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NATURAL HISTORY OCCASIONAL PAPER NO. 19

Proceedings of the Third Prairie Conservation and Endangered Species Workshop

Geoffrey L. Holroyd
H. Loney Dickson
Mona Regnier
Hugh C. Smith

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Provincial Museum of Alberta
Natural History
Occasional Paper No. 19
1993

PROCEEDINGS OF THE THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP

February 1992
At BRANDON UNIVERSITY
BRANDON, MANITOBA

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Geoffrey L. Holroyd
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Prepared and Published by:

Curatorial Section
Provincial Museum of Alberta
12845-102 Avenue
Edmonton, Alberta
T5N OM6

NATURAL HISTORY OCCASIONAL PAPER SERIES

Occasional Paper titles are published by the Provincial Museum of Alberta on subjects pertaining to the natural history of Alberta. Potential contributors are requested to submit manuscript proposals to the Assistant Director, Curatorial, Provincial Museum of Alberta, 12845-102 Avenue, Edmonton, Alberta T5N OM6.

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CATALOGUING IN PUBLICATION DATA

Endangered Species and Prairie Conservation Workshop (3rd : 1992: Brandon, Manitoba.)

Proceedings of the Third Prairie Conservation and Endangered Species Workshop, February 1992 at Brandon University, Brandon, Manitoba.

(Provincial Museum of Alberta natural history occasional paper no. 19
ISSN 0838-5971 ; no. 19)
Includes bibliographic references.

ISBN 0-7732-1220-5

1. Endangered species - Prairie Provinces. 2. Nature conservation - Prairie Provinces - Congresses. I. Holroyd, Geoffrey L. II. Dickson, H. Loney. III. Regnier, Mona. IV. Smith, Hugh C. V. Brandon University. VI. Brandon Natural History Society. VII Provincial Museum of Alberta. Natural History Section. VIII. Series: Natural history occasional paper no. 19. IX. Title

QH77.C2E52 1993 574.52909712

ACKNOWLEDGMENTS

The success of this workshop has been made possible by the generous contributions of energy and time from the following individuals and institutions:

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THE PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP AND PROCEEDINGS ARE PRESENTED WITH SUPPORT FROM:

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- BRANDON NATURAL HISTORY SOCIETY
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- TURTLE MOUNTAIN CONSERVATION DISTRICT
- WILDLIFE HABITAT FOUNDATION - MANITOBA

DEDICATION

To the memory of Clint Jorgenson who died at Watrous, Saskatchewan on Wednesday, October 28, 1992.

Clinton was born on May 5, 1939 at Swift Current. He resided in the Stewart Valley district until 1944 after which time he moved to Swift Current where he received his education. From 1963 to 1965, Clinton attended Kelsey Institute of Applied Arts and Science where he received his diploma in Wildlife Management. Clint was employed by the Canadian Wildlife Service from 1966 to his passing. From 1973 onward, he worked as the Area Manager at Last Mountain Lake, the first bird sanctuary in North America. His love of wildlife and the outdoors made a lasting contribution to the conservation of Canada's wildlife heritage.

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THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP - OBJECTIVES

The prairies of Canada support a major agricultural economy and a declining abundance of wildlife. Soil erosion and water quality threatens the long-term viability of agriculture. One-half of Canada's endangered and threatened birds and mammals share the prairies. Waterfowl populations have declined 60%. Wise soil, water, and land management are needed to solve these dependent situations. This workshop will address the issue of how to manage the prairies to promote sustained agriculture and to conserve the wildlife that are in jeopardy.

The objectives are:

1. To find economic and environmental linkages between agricultural and wildlife agencies that can be used to promote wise management of the prairies as suggested in the World Conservation Strategy.

2. To determine how to implement the World Wildlife Fund Canada's Prairie Conservation Action Plan which is the broad strategy to manage the natural portions of the prairie environment.

3. To encourage the recovery efforts on wildlife in jeopardy by determining the information needs for each species and possible management actions that could be undertaken.

This is an ambitious agenda but it is attainable because in western Canada we have many dedicated and talented people committed to the conservation of Canada's agriculture and wildlife. Together we can make it happen!

1. OPENING SESSIONS

CHAIRMAN'S OPENING REMARKS, THIRD PRAIRIE CONSERVATION AND ENDANGERED SPECIES WORKSHOP, BRANDON, MANITOBA FEBRUARY 14-16, 1992

R.D. Thomasson

Manitoba Natural Resources, P.O. Box 24, 1495 St. James Street, Winnipeg, Manitoba R3H 0W9

Good Morning. It has been my privilege to chair the Steering Committee that has organized this workshop.

This is, of course, the third workshop to be held on Prairie Conservation and Endangered Species. The first was in Edmonton in 1986 some six years ago. As I was thinking about the workshop origins I realized that it must have been about seven years ago that the real work of organizing that first workshop was underway. This workshop then marks the end of the first cycle and the start of the second cycle of focused interest in Prairie Conservation and Endangered Species activity. A lot has happened over the last seven years. Global events like the release of the Brundtland Commission Report, Our Common Future, and the recent Caring for the Earth Report, the successor to the World Conservation Strategy, have been major events. National events such as the initiation of the Endangered Spaces Campaign, the Report on the National Committee on the Environment and Economy, and State of the Environment Reporting have become well-known to us all. Closer to home, the Prairie Conservation Action Plan has been publicized and in Manitoba Endangered Species legislation brought into being. We have held workshops in each of the prairie provinces. There are a lot of accomplishments to look back upon over the last decade; no doubt there will be many more in the next.

With the foregoing in mind it seems most appropriate that we spend the next three days celebrating what has been done, looking toward what needs to be done, and replenishing our emotional batteries for the days ahead.

I, therefore, bid you welcome to this workshop and invite you to celebrate accomplishments, to re-commit projects which need to be finished, to commit to new challenges, and to return to the every day world refreshed in mind and in spirit.

ENDANGERMENT OF SPECIES - SOME THOUGHTS ON CAUSES

H.L. Sawatsky
Department of Geography, University of Manitoba, Winnipeg, Manitoba R3T 2N2

When we address the declared theme of this conference do we, I am moved to ask, include our own as one of the "endangered species?" In an age otherwise substantially defined by secularism, I find it paradoxical that, in large measure, our inherited cultural baggage, and indeed our own role projected, into the future, may still be said to be dominated by the content of the legend of Creation as told in Genesis, Chapter I. Verse 28 sums it up: "Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth." Further along, the emerging Judeo-Christian tradition bequeathed us the messianic approach - the redemptive one-shot solution - which we have, perhaps intuitively, thoroughly incorporated into the manner in which we address the perils we have largely ourselves authored.

As a predator, Man (*Homo sapiens*) was, not unlike other predators, an opportunist whose fortunes as a species waxed and waned with the fortunes of the prey. That is, until his innate sagacity caused him, very late in his history, to develop civilization, and the institutions and technologies to sustain it. Increasingly, he would be able to assert himself at the expense of competitive predatory species and, ultimately, to largely escape natural controls to his proliferation and the inevitable impacts which attended the continued, accelerated exercise of his innate predatory opportunism. Palpably, man had achieved ascendancy over his predator-competitors along the way to developing civilization. Small wonder, then, that he saw himself as a superior creation apart, upon whom devolved unrestricted license - and no reciprocal obligations - in respect to his conduct vis-a-vis all other species who shared their living space with him.

The cumulative product of man's sagacity did not, however, protect him entirely from catastrophic events. When these occurred, nonetheless, nature was perceived to be in revolt, and needful of "correction," correction to be achieved through intensified subjugation. Stories and myths, sacred and secular, infused successive generations with powerful messages. Jacob, the sedentary husbandman, obtains his hunter-woodsrunner brother Esau's birthright quite "properly," albeit, a dispassionate observer might argue, opportunistically and subject to an unconscionable contract. The masterless Esau was, after all, not "filling the Earth, and subduing it," and so, the message is, his rights were properly forfeit to one dedicated to a limited polyculture restricted to a few species of plants and a few of animals, all dedicated to the sustenance and expansion of the one dominant species.

Ultimately, man would become the ultimate domesticate, the ultimate monoculture, anthropocentrically viewing any realm outside his control, from his own utilitarian perspective, as howling wilderness, the abode of the sinister, of chaos, of the enemy as personified by unsubdued nature. The language which evolved, evoking man's relationship to the natural world, is such as is appropriate to struggle with an adversary whose subjugation is at the focus of high resolve. "Forcing the forest into retreat," "subduing the stubborn sod" were, from the utilitarian perspective, laudable endeavors in the ongoing struggle to order the wilderness. Indeed, the highest good, according to revealed prophecy and attainable only in the afterlife, was defined as admission to residence in a divine city, exquisitely ordered, a perfect cube all of precious metals and precious stones, - with but one single tree - its invited guests individuals of great virtue and exclusively of the one species which, since time immemorial, has known itself to be a separate and superior creation.

As a species we have shown ourselves to be largely unencumbered by a cultural imperative to exercise, at the very least, a broad, nonanthropocentric stewardship. If, as our civilization became more complex and our knowledge proliferated but our wisdom remained, at best, static, it should not amaze us that we pursued the creation and amplification of institutions essentially oblivious to all but their own narrow mandates.

In the course of exercising the mandates and performing the duties assigned them by society, our institutions project pervasive and, cumulatively, powerful messages. I shall cite only a few whose influence serves to illustrate. Municipal government was established on the prairies in 1880. Its revenue base was the land, evaluated, for revenue purposes, according to its perceived potentials for cultivation. Land which failed to meet the criteria for cultivation was designated as wasteland, to be taxed at a lower rate, but still taxed. It occurred to none to designate it, not wasteland, but ecological reservoir, vital to the continued well-being of the environment and hence of society-at-large, and to emphasize this realization by an insightful determination not to tax nature at all.

The Canadian Wheat Board, since 1935 the monopolistic regulator of much of the market in the primary products of prairie agriculture, provides another case in point. Its mandate is marketing, not ecology. Since its inception, producer access to the marketplace via the Wheat Board has been based on "improved," that is, cultivated acreage. Since 1935, the "improved" acreage registered by the Wheat Board has increased by well over 20 million acres. The producing acreage, on the other hand, has increased by less than half as much. The obvious conclusion to be drawn is, that in the pursuit of delivery rates and volume-entitlements, landowners rationally "improved," through permanent mutilation, in excess of 10 million acres with no realizable agricultural potentials. They did this in the full knowledge, also, that they were, in any event, subject to taxation on the acreage in question and that, furthermore, most "natural" produce it might bring forth was, by law, the property of the Crown. The ultimate legacy is ecological and esthetic degradation of the landscape and the endangerment of species. Moreover, to the extent that such landscape-degrading "improvements" engendered economic costs, these were, and continue to be, deductible from realized taxable income. Indeed they have, at times, been directly subsidized by government.

The consequences have, naturally, become increasingly apparent. Countervailing thrusts, private and/or public, have been initiated to retain and restore elements of the diminishing ecological reservoir. Such initiatives, perhaps predictably, tend strongly to be addressed to specific species and/or designated areas. Control is achieved through the exercise of economic and/or political leverage. In consequence, such initiatives are vulnerable to finite time horizons associated with non-permanent, monetized terms of tenure and/or fluctuations in political will and commitment. Conservation initiatives addressed to private property and based on the payment of economic rent equivalents are highly vulnerable over time. Their funding base, whether from public or private sources, tends to be "soft," and limited to a predetermined maximum in the former, donor generosity in the latter case. The more successful their recruitment of desirable conservation habitat, therefore, the more dilute becomes the "bribe" they are able to offer. Economics has been described as the "dismal science," largely because of its failure to tell us with some certainty until after the event that which we would have preferred to know before. Moreover, it has caused us to largely confuse "value" with "price" and "growth" with "progress."

Even more sinister, I contend, is the concept of "opportunity cost," expressed as a discount rate. Rational decision-making in relation to conservation and retrieval in the context of the ecological reservoir inevitably leads to inhibiting conclusions. The more potentially deferred the anticipated benefits, the more inhibiting the opportunity cost. Thus, in terms of rational decision-making in the context of an annual discount rate of 6%, an investment in ecological retrieval must, over a 50-year term, generate imputed benefits equal to more than 17 times the initial economic commitment undertaken in a competitive, monetarily rational marketplace. In the course of a century, the factor becomes 320! Should the discount rate be 10%, the numbers are, for 50 years, 107, for 100 years 12528 times the initial investment. In other words, if rationally allocated funds borrowed at 10% do not promise deferred benefits in 100 years, equal to 12528 times the initial commitment, they will be diverted elsewhere.

That being said, it would appear to be in order to suggest that the strategy directed at promoting the future survival of endangered species must depart from the notion of buying our way out of an increasingly threatening bind. Rather, we must set about imbuing our institutions with operational ethics whose perceived messages cumulatively promote ecologically sound rational collective responses just as effectively as they have hitherto generated collective rational responses of an ecologically unsound, destructive nature.

The opening question was, "are we part of the theme of this conference?" Let's be candid about it, we are the theme! We have assessed our "dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth," and we have found it wanting. Those subjects of ours do not, to the best of our knowledge, ponder their endangerment and possibly imminent extinction. We do that, in the emerging conviction that the continued single-minded pursuit of the ascendancy and proliferation of our own sovereign species will, ultimately, deprive the sovereign as well as the subjects of the basis of survival. That being the prospect, we had better begin coordinating the messages emitted by our social, political, and economic institutions into a constellation of incentives such that rational decisions generate constructive outcomes. Farmers and landowners have consistently and pervasively demonstrated that they respond rationally to signals emanating from the various institutions to which they must respond. In respect to the endangered ecological reservoir the indicated imperatives are: "Retain; Redress; Retrieve." To achieve that, the signals must be brought into alignment. It's as simple—and as dauntingly complicated—as that.

AGRICULTURE - THE VILLAIN OR THE SALVATION OF WILDLIFE?

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The period beginning in the late 1800s to the present has seen many changes on the prairies. From an agricultural perspective it has been one of the most dramatic in world history. In a little over 100 years we have come from the oxen and single furrow plow era to space-age agriculture. We have advanced our production efficiency second to no other industry in the world and to no other country in the world - from where the early settler fed himself and his family to where one farmer now feeds over 30 people. But this has not been without cost. We have seen the total disappearance of some wildlife species and the steady decline of others to the point of being endangered. We have also seen the degradation of our soil base to where some of it should be placed on the endangered list. We all-too-often blame the farmer for this, but I don't believe he can be held solely responsible for either the demise of wildlife or the state of the land. The farmer's mandate was to produce food - and he did that the best way he knew how. We must also recognize that some wildlife species have thrived under our agricultural system; the White-tailed Deer (*Odocoileus virginianus*) is a good example.

I would like to focus the balance of my allotted time on one important species—a species that showed a rapid increase in numbers on the prairies—beginning about 1875 to where it reached some 255,000 in numbers by 1921; peaked in population at 297,000 in 1941, declined to 210,000 in 1961, to 154,000 in 1981 and 148,000 in 1986—a 50% drop in 50 years—and the decline has accelerated in the last years. The species to which I refer, of course, is the prairie farmer. He is an endangered species. And because he's endangered, it could place a great many more wildlife species in jeopardy.

If we can accept the premise that agricultural development has, in some way, been part and parcel to the demise of some wildlife species, lets follow the development of agriculture in western Canada and maybe we can better appreciate what happened.

When the white man came to the prairies it was subsistence living—he and his family lived in harmony with nature. He expanded his cultivated acres and gradually had produce to sell or trade. It was the best and easiest land to develop that was cultivated. The heavy bush, the hilly land and wetlands were generally left untouched—with the exception of the Red River Valley which was extensively drained. The native lands were home to wildlife like they had always been.

The drought and depression of the '30s, followed by the second world war marked the beginning of a massive change to the prairies. When the farm boys came home from the war in 1945 they took up the home farm, and often the neighbours farm as well, they brought land back into cultivation that had been abandoned—weather was in their favour, prices were in their favour, youth and courage were in their favour, and, most of all, they had improved technology and powerful equipment. Weed control chemicals and commercial fertilizer appeared on the scene. Big bulldozers, developed for the war, were available to clear land and drain sloughs. The second agricultural revolution was on—agriculture was king. Little thought was given to the capability of the soil to sustain agriculture—technology could compensate for soil degradation—or at least so we thought—all land was considered agriculture land. There was certainly less thought given to the wild critters that lived on the land. But why should there? After all, farmers make their living growing grain or raising cattle. For many years, intensified agricultural activities had little, or unrecognized, detrimental impact on wildlife or on the land base. So what was the concern?

We failed to recognize the relationship between our activities and the resources, both soil and wildlife. We are now experiencing the effects of our short-sightedness—both in terms of soil degradation and wildlife numbers.

The degradation of the agricultural land base as a result of outdated farming practices coupled with the decline of the farm population are two of the most perplexing issues in this country. Both will have a bearing on what happens to wildlife.

Why is the farmer so important? First of all, the farmer owns or controls over 90% of the habitat on the prairies—habitat which I understand is the home for many of the endangered species. In other words, the farmer owns the nursery. What he does with the nursery will determine the fate of many wildlife species.

In the past, it goes without saying that relations between farmers, wildlife and wildlife advocates have been anything but friendly. Ducks by the millions destroyed farm crops, Elk (*Cervus elaphus*) and deer trampled feed stacks and spoiled grain piles, Beavers (*Castor canadensis*) flooded hayland, and on and on it went. There was a time, not too long ago, when the farmer received no compensation for these losses—he was expected to bear these costs as a good citizen and conservationist. A farmer who had just lost 150 acres of barley to ducks is not very sympathetic to the cause of nature. Granted, compensation to farmers has improved over the last few years but in many cases, it is still inadequate.

Contrary to popular perception, the farmer is not your enemy—he is not adverse to wildlife. The problem is that he has never had a viable option. There was no money in raising wildlife. In the future, if we want wildlife, particularly those species that make their homes on the farm, that will have to change; the farmer must be given an option. Wildlife is in competition with grain and cattle. You can talk all you like about wildlife being a good indicator of the health of the land but the farmer has difficulty in relating a beautiful, clean, disease free crop of wheat that has just been ruined by wildlife to the importance of an owl or a falcon. When he can make that relationship in economic terms, he will be more receptive. In other words, if you expect the farmer to raise wildlife for the benefit of society, society had better be prepared to pay.

The opportunity to directly or indirectly place wildlife as a product of the farm has never been better. In the next few years, we will see changes on the farm scene every bit as dramatic as those of the late 1800s or the post-war era. Sustainable agriculture is the buzz word. There is a growing concensus that sustainable agriculture involves giving much more attention to the environment and the social and economic consequences than in the past. However, all of these sustainable development concerns will be fertile ground for increased conflict. Farmers do not change without good reason.

However, we cannot continue to farm the way we are; farm economics will dictate that; the capability of the soil to sustain agriculture will dictate that; and climate changes, if they materialize, will dictate that. The environmental movement will have a say in how we farm—just look at what the animal rights movement is doing. Reduction in agricultural subsidies currently under negotiation with the General Agreement on Tariffs and Trade talks will change farming practices; and probably the most significant impact will be as a result of what happens in China and Russia when high-tech agriculture catches hold and they no longer need our wheat.

The next decade or two will see a major change in the farmer himself. The average age of Manitoba farmers is 57+ years. These guys don't have many years left—physically, and some of them unfortunately, have damn few years left economically. Who is going to take over the land? There is not much incentive for a young man to go into farming today.

The farm scene has two ways to go—big corporate farms owned by big business or corporate farms owned by farm families. In either case, farming will be big business. The family farm, as a way of life is a thing of the past.

If we go the route of the big business corporate farm, how the owner sees the farm will largely determine what is produced on that farm. If the corporate board has a soft spot for wildlife, it may set aside some land for wildlife for the pleasure of the board and the company's employees. But if the farm is strictly business, wildlife will have no place—unless it pays its own way. The family corporation may have values that are different because the family is closer to the land. Hence, the need to support the family farm.

We are in a very complex dilemma that is going to test the ingenuity and skills of all concerned if it is to be solved to our mutual satisfaction.

What has to be done? First of all, we have to stop throwing darts at each other. We have to develop a partnership—we have to coexist on the same landscape—and there is room and need to do that.

Second, we must somehow enact a change in farmer attitude. There is a perception amongst many farmers that you're not a farmer if you don't make your living from growing grain or raising cattle. But, a dollar made from selling a recreation service or hunting rights is of equal value to one made from wheat and it may be more environmentally friendly.

Third, we have to change the attitude of the agricultural bureaucrats who think that the only solution to the farm crises lies with agriculture. They fail to recognize the opportunities of interfacing with other resource disciplines for the benefit of the farmer or the land.

Fourth, we have to farm in accordance with the capability of the land base so as to sustain agricultural production but not at the expense of other natural resources.

Fifth, we have to change agricultural policies to make them more environmental friendly. But you won't do this by confronting the farm organizations or government. You have to come at it from the side, such as the Green Plan; through the back door if you like.

Sixth, we should be looking at ways of keeping the money that is currently going to the farmer as farm subsidies still flowing to that farmer. Subsidies have to be decoupled from agricultural production and coupled to the environment.

We have to support conservation farming. Farmers will listen to you and will be more receptive to implementing environmental farm plans if you have something to put on the table—so we pay the farmer not to produce more grain but to be a steward of the ecosystem. Ontario is leading the way in this respect. There, all 40,000 farmers are being encouraged to have an environmental farm plan by the year 2000.

Seventh, we have to work with the kids—the 4-H clubs, the schools, particularly the city kids because they have the least understanding of the rural scene.

Eighth, we have to find new and innovative ways of raising money for wildlife; forget the governments.

Ninth, we must form partnerships—we must cooperate because whoever thinks he can go it alone is dead.

I wouldn't want to leave you thinking that nothing is happening. Agriculture is rising to the challenge to stop soil degradation. Under federal/provincial soil and water accords, "Farming for Tomorrow" program will see some $18.0 million spent in Manitoba over a 5-year period. Soil conservation is the main thrust but it also includes conversion of fragile lands to a more stable use. Prairie Farm Rehabilitation Administration is administering the Permanent Cover Program aimed at taking 600,000 acres out of cultivation by seeding to forage or trees for terms of 10 or 20 years. The North American Waterfowl Management Plan is a 15-year $1.5 billion program aimed at establishing and securing some 3.6 million acres of habitat in Canada - the majority on the prairies. Much of this acreage will be cultivated land converted to dense nesting cover.

The Manitoba Conservation Districts have really come of age in the past few years. Initially, program emphasis in most districts was drainage with minor soil programs. More recently programs have broadened to include wildlife habitat and water management.

Manitoba Agriculture has just released a strategic plan called "Vision for the '90s." Granted the emphasis is on production and marketing but they are looking at sustainable development and value added crops.

The federal government's "Green Plan" is focusing, among other things, on initiatives that will include measures aimed at halting soil degradation and enhancing compatibility between agriculture and wildlife.

In summary, I think there is a good reason for being where we are. There is certainly good reason to have to change. We must recognize that we cannot enact change on our own. We must work together but we must recognize that the farmer is the key to much of our success.

SOME THOUGHTS ON AGRICULTURE-PRAIRIE CONSERVATION INTEGRATION

Garry Trottier

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First of all let me convey a sincere apology from Director, Gerald McKeating, who was unable to participate on this morning's most important panel, and of course, could not attend this workshop. Due to the federal government expenditure freeze Canadian Wildlife Service (CWS) attendance had to be reduced and Gerry reasoned that it was more important for technical staff to attend than himself.

Both Gerry and I congratulate the organizers for focusing on the issue of integrating agriculture and prairie conservation. We are glad to be among conservationists, including both producers and wildlifers and my fellow panel members, to discuss the use of the land.

At one time or another I think we have all heard the comment from farmers—wildlife doesn't pay the bills so why should I save their habitat. This feeling has certainly changed forever the way wildlife stakeholders do business on the prairies.

As wildlifers we, and I am speaking now for all wildlife interest groups, have been working very hard over the last few years to secure marginal acres and improve cultivated acres for wildlife habitat. The strategies have been many, and, I believe, very proactive.

Allow me to take a few minutes to comment on some of these efforts and I apologize for not mentioning all the prairie programs in effect.

Land acquisition is ongoing on a very limited scale. This is an expensive option and is used only to secure outstanding or rare examples of habitat. Local governments and landowners are often wary because such efforts are perceived to threaten commerce and the local tax base. However, proponents know this is the surest way to protect habitat.

We have seen much progress in integrated planning and management decisions. This includes the formation of conservation districts, agricultural service boards, and integrated decision-making at the municipal level where the work gets done and where wildlife stakeholders have been able to become part of the land management process.

Leasing to protect critical habitat is a major activity. It is common to several provincial wildlife programs and the North American Waterfowl Management Plan (NAWMP), including the Adopt a Pothole and the HELP (Habitat Enhancement Land Use Program) programs in Manitoba, the Prairie Pothole Project in Saskatchewan, and Prairie CARE (Conservation of Agriculture, Resources and the Environment). Also there are the non-waterfowl programs of Buck for Wildlife in Alberta, and the Critical Wildlife Habitat Program and Tall Grass Prairie Project in Manitoba. Wildlife Habitat Canada (WHC) has cost-shared many of these provincial initiatives. In essence landowners are paid a fair rental rate for leased land but the technique is a gamble as it protects landscape only while there is money available. And as you know, funding is getting more difficult to obtain. On the other hand leasing is the option most preferred by landowners.

The Prairie Farm Rehabilitation Administration (PFRA) is reclaiming cropped marginal lands to permanent cover under the Permanent Cover Program (PCP) and already we are into the second generation or PCP2. Wildlife programs have been attempting to piggyback wherever there is an opportunity to increase wildlife use by offering further incentives so farmers will alter their forage conservation and grazing management practices, or plant native seed mixes, or rehabilitate wetlands. Unfortunately, few wildlife advances have been realized under this program so far and I hope the reasons for this can be addressed during this workshop.

There are also efforts to provide producers with financial incentives to adopt conservation farming techniques. An important component of the NAWMP, this involves fair incentives paid to farmers for modified agricultural uses which are wildlife-friendly.

Wildlife dollars are being used to support on-farm projects that demonstrate conservation farming techniques. Under Prairie CARE planned grazing systems, stubble mulching, chemical fallow, underseed clover, direct seeding (zero-till), and winter wheat projects are funded so that farmers can experiment with new technology without incurring financial risks. This is an educational technique to encourage broad adoption of desirable practices.

Support for research into crop management systems which have potential to provide wildlife habitat is coming from wildlife interests. For example, Ducks Unlimited is directing funds to develop winter wheat cultivars and management techniques because this cropping system has a unique potential to provide safe nesting cover for ground nesting birds including ducks.

Another important activity is research on the wildlife responses to conservation farming techniques. CWS, the Institute for Wetlands and Waterfowl Research, Saskatchewan Wetlands Conservation Corporation, and university interests are involved in directed studies funded by the Evaluation Program of the NAWMP.

The above are just a sample of the numerous cooperative approaches with agriculture. Most put money directly into the hands of agricultural producers. On balance then, wildlifers are already heavily integrated with agriculture.

We have also lobbied and won significant improvements in the crop damage prevention and compensation programs. And last but not least extensive lobbying effort has been expended particularly by WHC for adjustments to agricultural policies which would tie agriculture support programs to conservation.

For the most part our efforts have been successful with one disappointing exception—agriculture support programs. And here I will quote what Dr. Fred Bentley, former Dean of Agriculture at the University of Alberta, recently had to say about the new programs, particularly GRIP, "the Gross Revenue Insurance Program, has encouraged bad farming practices by paying on the basis of seeded acreages." On a trip between Wainwright and Medicine Hat Dr. Bentley was appalled to see long stretches of bare-tilled soil left for overwintering and he stated, "I don't think people should be paid subsidies on an acreage basis to farm as badly as I saw on that trip." And in another testimony just a few days ago Western Canadian Forage Processors complained that because GRIP does not cover forage production they anticipate an 18% reduction in seeded forage acreage this coming year. Such shortcomings do not bode well for soil and water conservation.

I don't want to belabour the obvious, but our greatest challenge is that our conservation efforts cannot compete with or neutralize the negative effects of such policies on wildlife habitat. Until there are substantial changes to agricultural policies net habitat loss will be a fact of life.

Solutions to this dilemma remain the challenge of this workshop. As you deliberate keep in mind that we have to build on the positive actions that are currently being undertaken by federal and provincial wildlife habitat programs, conservation organizations, environmental groups, and conservation-minded producers.

Now I think we should all be aware that producers are honestly concerned about their conservation image. I had an opportunity three weeks ago to attend the Alberta Conservation Tillage Society Workshop in Edmonton and I was encouraged to learn that the agriculture interests want to improve their image as stewards of the land and the environment. As one producer and conservationist, Elmer Kure put it, and I quote, "farmers have not done a good job of getting the conservation message out because of their narrow pro-production politics. It's time to put aside the B.S., we need a positive image of how we manage the land, or the four percent of us who still live out there will not be supported by society as we know it today."

While acknowledging that it is necessary to break and drain some of the land to make a living Elmer, pointed out that the need to completely eliminate the rough, marginal acres in order to make a buck seriously tarnishes agriculture's conservation image and is economically unsound.

Even though the agricultural community acknowledges a conservation image problem one has to sympathize with producers because the politico-economic system has let them down. At this time farm survival is the number one priority. Therefore, we must be sensible in directing our criticism concerning conservation issues and land use because producers are getting a little bit weary of all the nit-picking. The fact that they may feel threatened can result in a backlash against the conservation lobby.

An example of a backlash has just recently surfaced in Alberta. Livestock producer associations are lobbying to have administration of all agriculture dispositions on public lands transferred from the Department of Forestry, Lands and Wildlife to the Department of Agriculture, in essence from an agency geared to meet the needs of a broad spectrum of land users to one with a much narrower focus. Why? Because recreationists and conservationists have largely given the impression that they don't want cattle on public lands. I don't believe that should be our view.

In this regard, we must keep in mind that landscapes supporting livestock grazing are some of the most extensive and well-managed tracts of native prairie habitat left. Ranching has been instrumental in protecting prairie from other destructive interests. Ranchers are strong allies in conservation and must be treated as such. So let's strengthen our linkages with these people, not alienate them.

Now, before I close, Gerald McKeating wanted me to mention some new initiatives that CWS will be taking to address wildlife habitat and endangered species conservation needs on the prairies.

Under the federal Green Plan CWS will initiate two programs—Endangered Spaces and Safeguarding Healthy Ecosystems. For the Prairie Biome we will hire a Nongame Biologist and secure a program budget of $80,000 over 5 years. In addition, a Partnerships Coordinator will oversee a 4-year budget of $350,000 involving research, possibly land acquisition, and cooperative land-management agreements. We expect this latter activity to result in new ventures not only with PFRA, Agriculture Canada, and the Department of National Defence (DND), but also with provincial counterparts where opportunities arise.

Also of note, CWS has initiated two research projects which will provide some much needed information on avian communities: 1) in wooded draws, and 2) on Heritage Farmsteads in Saskatchewan. Results from this work will help CWS provide recommendations to agriculture and wildlife agencies on management of such habitat throughout the Prairie Biome.

And finally, as I am sure you are already aware, we anticipate signing a Memorandum of Understanding in March with the DND for designation of approximately 480 km^2 of the Suffield Block in Alberta as a National Wildlife Area (NWA). This will be a significant contribution to the goal of protecting 12% of the country as defined in the Green Plan. Incidentally, some of this proposed NWA is currently managed cooperatively for wildlife and livestock grazing with excellent results.

In closing, there are some important challenges that you as delegates should consider during this workshop. All offer opportunities for conservation to benefit. Producers will be looking to diversification as a means to survive. What suggestions can we make in that regard? Agriculture support policies will continue to drive land management practices so we must keep pressing for conservation links. And stewardship must take a higher profile in our efforts to integrate with agriculture.

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SOIL CONSERVATION, DIRECT SEEDING AND WILDLIFE. WHERE AGRICULTURE, THE ENVIRONMENT AND WILDLIFE CAN ALL BENEFIT

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ABSTRACT

Across the prairie provinces, traditional agricultural practices have dramatically changed prairie ecosystems. Today, mounting agricultural, soil and water conservation concerns along with increasing concern about wildlife diversity are demanding changes to traditional agricultural practices. Direct seeding, an agricultural practice where an annual crop is seeded directly into standing stubble, may hold the key to better prairie soil, water, and wildlife habitat conservation. This session will highlight: 1) the potential soil, water, and wildlife habitat conservation benefits to the prairies, 2) the practical observations of a direct seeder, and 3) a practical "How To" video about direct seeding, soil/wildlife conservation, and forage seeding in saline and marginal agricultural lands.

DIRECT SEEDING: POTENTIAL SOCIO-ECONOMIC AND CONSERVATION BENEFITS

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INTRODUCTION

For the purpose of this paper, I define direct seeding (zero tillage) as planting small grain crops into standing stubble without any tillage operations. In western Canada, the spring-seeded crops—wheat, barley, flax, and canola (or rape), and fall-seeded winter wheat and fall rye, are the major zero-till crops. Sunflower, corn, oats, and spring rye are less important as crops.

Direct seeding requires precision technology and superior management. During harvest of the previous crop, the straw is chopped and spread evenly with the chaff on the field. For fall seeding, one or more herbicides are sprayed to kill fall-germinating weeds, then a shallow-depth, precision seeding is done in late August to mid-September.

Herbicides and fertilizer are usually applied in spring for spring-seeded crops. Weeds are "burned off" with a non-selective herbicide, usually glyphosate, trade name Roundup®, to kill all green growth prior to crop emergence. After either the fall- or spring-seeded crop is up and growing, herbicides are used selectively just as in conventional crops.

Cover increases with the growing season. Fall crops emerge in fall, grow until freeze-up, then die back; they re-grow from the crowns early in spring (April) and get well ahead of spring-seeded crops. Farmers harvest from as early as late July to mid-September, often by straight combining.

As the ecology of the fields changes with the years, physical and biological factors mould and interact; productivity may decrease initially, to rebound and improve with time. Experienced farmers generally see yield improvements in individual fields after three or more years of direct seeding. With proper management, environmental benefits accrue, assuring economic and wildlife benefits in step.

ENVIRONMENTAL BENEFITS

Soil

Direct seeding has been shown to reduce erosion by as much as 90%, and retard and resolve salinization processes. The decomposing plant materials increase pore and root channel size; facilitate aeration, microbial, earthworm, and insect activity; and thus enhance tilth and organic development.

Moisture

Stubble retains up to 50% more field moisture than cultivated cropland. Standing stubble traps much more snow, funnels meltwater and rainwater into the soil through root canals and earthworm burrows, and cools and reduces evaporation by surface winds. With increased organic content, the soil can absorb and hold more water in the root zone.

Environment

Better moisture retention on zero-till fields helps reduce ponding, runoff, water erosion, flooding, sedimentation and pollution, and balances summer stream flows. Erosion is almost eradicated, and reduced soil salinity allows for new plant growth in fields and headlands.

Pesticides and fertilizers are better kept on the target areas, reducing overland movement into neighbouring farms, human habitations, wetlands, and waterways. Modern herbicides used in direct seeding are relatively shorter-lived (Sprinkle et al. 1975), less toxic, and more efficient than the soil-incorporated types; they require less active ingredient (up to 20% less) and so can actually reduce the total amount of active product applied. Glyphosate (Batt et al. 1980) and POAST® (Batt et al. 1985), two major herbicides used in zero-tillage, were shown to have no effect on egg hatchability.

More fungicides may be needed to combat diseases that proliferate in the moister environment of the zero-till field. Insecticides requirement should decrease over time as insect/invertebrate communities achieve a better balance by harbouring a larger compliment of predatory insects. As well, predatory birds and small mammals can help control insect pests (Warburton and Klimstra 1984, Basore and Best 1982).

ECONOMICS

We must keep in mind that it takes several years for the ecology of a field to change under a new cropping regime, and for increasing productive capacity to translate to economic improvement. However, in the case of direct seeding, several indicators may appear along the way. The farmer sees improvements immediately in some aspects of management: savings in time and fuel (up to 32-50%), reduced machinery depreciation and maintenance (15%), and even the elimination of stone picking. Yields will eventually improve, at least in dry years. Net savings have been estimated at 15-20%.

Over time, summerfallow should decline as annual moisture savings allow, extended crop rotation will break disease/pest cycles, and improving technology will make herbicide, fertilizer, and other cropping inputs more efficient. In the future, progressive provincial and federal agricultural policies must be moulded to facilitate rural conservation objectives and provide a more friendly economic environment for direct seeding on the dry prairies.

WILDLIFE BENEFITS

The retention of stubble cover year round on large acreages of prairie farmland, in place of intensive cultivation, will create a new landscape which should benefit many species of wildlife. In farmlands associated with a diverse mix of natural habitats, this potential is especially enhanced. There are presently very little data to test this theory because such landscapes are few and only recently emerging. However, there have been, during the prairie-wide conservation movement of the 1970s and 1980s, many indications that direct seeding could provide significant wildlife benefits and that this technique will become established on many farms over the 1990s.

It is well-known that many species of birds and mammals use uncultivated stubble fields in all seasons to feed on waste grain, weeds, insects, and small vertebrates, and as cover from the elements and for nesting. Cowan (1982) documented 27 species of birds and 16 species of mammals inhabiting direct seeded fields in Manitoba; of these 14 bird species nested in the stubble. Higgins (1977) in North Dakota and Basore and Best (1982) in Iowa found a rich community of birds and mammals on zero-tilled land.

I will describe some benefits to ground nesting birds, based on my own and others' research on duck production in spring direct-seeded fields in Manitoba (Cowan 1982), and fall direct seeding (winter wheat) in North Dakota (Duebbert and Kantrud 1987). Five species [Mallard (*Anas platyrhynchos*), Northern Pintail (*A. acuta*), Blue-winged Teal (*A. discors*), Gadwall (*A. strepera*), and Northern Shoveler (*A. clypeata*)] nested in these fields. Nest densities ranged as high as five nests per 100 acres (quarter-section field). In Manitoba, nests were located before seeding and protected from drill damage; success rate was 60%. Predation was much less intensive in the direct seeded fields than in the neighbouring cultivated fields (e.g., 40% and 91%, respectively). In the North Dakota winter wheat crops, the adjusted success rate (Mayfield) was 27% (Duebbert and Kantrud 1987). By comparison, nest densities in native cover types in and adjacent to farm fields in the prairie potholes region are generally much higher, however, nest success rates are consistently below 15%, the rate required to sustain duck populations (Greenwood et al. 1987). This can be categorized as a nesting trap.

How beneficial zero-tillage will be to wildlife in the future depends on how the technology evolves. For instance, a recent preliminary study at Minnedosa (Fisher, pers. comm.) showed a reduction in nesting effort from the earlier study by Cowan (1982), probably because of declining breeding populations and the use of seed drills that are agronomically efficient but bury a good portion of the trash cover. Nest losses were high, again due to the types of drills used: the hoe openers were relatively wide and so dragged the nests, spread and buried the eggs, and wide packing wheels left no room for nests to escape being crushed. During my own study (Cowan 1982), where narrow disc openers and packing wheels were used, few eggs were destroyed and some hens returned and resumed incubating, with a 50% success rate. It thus behooves wildlife managers to promote this latter drill type where feasible and perhaps invest in technological development.

Here are a final few points regarding wildlife in direct seeded fields. The several studies done so far point to the probable development of better balanced communities of animals utilizing stubble fields. There is a large reduction in field traffic and thus a reduction in annual impacts on field and slough edges, tree bluffs, and other habitats within and adjacent to the fields.

Better retention of available water in the soil due to retaining stubble may reduce runoff to the low spots, eventually decreasing the number and size of ephemeral ponds and possibly bird use. Ponding causes delays and disruption in seeding, late crop ripening, and increased cost for the farmer. We do not know the total extent and ecological effect of this drying phenomenon as yet. Access to more arable acres could alleviate many of the economic concerns of agriculturists and promote a better attitude toward wildlife habitat in general. In the end, it could prove beneficial to the movement for conservation, multiple-resource management, and sustainability.

SUMMARY

Direct seeding holds great potential to alleviate the environmental woes that excessive cultivation has brought on millions of acres of cropland across North America. It can increase soil productivity and remove many of the inappropriate management treatments presently in vogue. At the same time, direct seeding can benefit wildlife by providing large acreages of safe habitat in otherwise sterile landscapes.

The optimistic view presented here is predicated on the bottom line requirement that the direct seeding system be economically feasible and acceptable to the farmers who must depend on it to provide profitability. But this will happen on a permanent basis only when all of the pieces come together. Research, development, trial, acceptance, and economic factors must be driven by government policies that provide the incentive and the means. We are a long way down that road today but there are some miles yet to travel.

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HOW AGRICULTURE AND WILDLIFE BENEFIT FROM DIRECT SEEDING ON MY FARM

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Tisdale, Saskatchewan, "The land of rape and honey." This slogan was used for many years in my home town and has grabbed a lot of attention over the years. Now, with the introduction of canola, the slogan has become out-dated but it does illustrate the diversity of cropping opportunities in northeast Saskatchewan. On our farm we grow pulse crops, oilseeds, pedigreed grass seed, Alfalfa (*Medicago sativa*), and the more traditional cereal crops. All of these are now direct seeded. We are in the grey black soil zone with a rolling topography so our land is very subject to water erosion and during severe winds the soil can become airborne.

In 1955 soil conservation started on our farm because of uncontrolled erosion. At that time I was not old enough to be very involved with the decision-making but I can remember how my father agonized over this problem. He started grassing water runways which helped, but this was not the total solution.

The next major step occurred when I became involved in the farm and we started continuous cropping some twenty years ago. Conventional continuous cropping is very labour intensive and requires high input costs. In an attempt to reduce these costs I started experimenting with direct seeding, which is the reason I am here today.

THE BENEFITS OF DIRECT SEEDING

The economic benefits from direct seeding were pretty much what I expected; a significant reduction in input costs, some increase in yield, and total control of soil erosion.

Having been involved in local wildlife and habitat retention programs for years, I did foresee direct seeding as being beneficial to wildlife but I was pleasantly surprised at how quickly some of these benefits became apparent. There was increased nesting of the larger species such as Sharp-tailed Grouse (*Tympanuchus phasianellus*) and ducks. I noticed an abundance of mice and small birds. Also, the population of Red Foxes (*Vulpes vulpes*) and Coyotes (*Canis latrans*) multiplied, no doubt due to the fact that their prey was more abundant! In my opinion this increase results from:

1. Stubble left standing over winter to collect snow, provides food such as grain thrown over combines, which is readily accessible because it is on the soil surface.

2. The snow provides protection for Sharp-tailed Grouse to burrow in during cold winter nights. I'm told that the ability to do this is very important for Sharp-tailed Grouse survival in our cold winters.

3. The trapped snow allows for a much slower runoff in the spring resulting in less silt deposits in our waterways and an improved habitat for fish and other aquatic wildlife.

4. Stubble left standing provides immediate browsing for deer in the spring. I have often seen large herds of deer feeding on my fields in early spring. They appear to be after the volunteer grain growth from the previous fall.

5. Again, spring stubble provides cover for nesting birds, particularly Mallards (*Anas platyrhynchos*). I have also noticed that if a duck's nest is destroyed by direct seeding, they will often nest again in the same spot.

CHEMICAL WEED CONTROL IN DIRECT SEEDING

No doubt many of you are thinking that direct seeding requires chemical weed control as indeed it does. I also know that you are very concerned about the impact of herbicides on our environment. This may sound contradictory, but I feel that the type of chemical control used by a direct seeder is (compared to the alternative) beneficial to wildlife.

A ground rig with shielded booms is the type of spraying unit used on my farm. For direct seeders the most effective herbicide is glyphosate (trade name Roundup®), generally used in a split application, one half litre per acre in the fall to control perennial weeds and winter annuals, plus one half litre per acre in the spring just prior to seeding. This practice results in an increase in the amount of glyphosate used but conversely a decrease in the use of other, possibly more environmentally unfriendly herbicides, thus having a positive, overall effect on wildlife, soil, and water.

Glyphosate is known to produce no particular adverse effects to mammals, birds, or aquatic organisms because of its low toxicity and quick soil absorption. Speaking as an agricultural producer, actively practising conservation on my farm, I feel fortunate to have access to a herbicide of such efficacy, both agriculturally and environmentally.

Thank you for this opportunity to share with you some of the things that we are doing on our family farm, in attempting to preserve the land and its wildlife for future generations.

HAYING AND GRASSLAND BIRDS: INTRODUCTORY REMARKS

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It seems that there is not a lot of structured research currently being done on the effects of haying on wildlife. Most people I spoke to gather information on haying incidental to other work and did not feel they had sufficient data to present a paper at this workshop. They did share their general impressions with me and I have included them where possible.

Most such research was conducted in the United States decades ago because of haying's suspected deleterious effects on waterfowl and pheasants. Although the effects of haying on gamebirds are known, little progress has been made in improving avian productivity because instituting widespread changes in haying practices is difficult and expensive.

We need to become more aware of the relationship between haying and birds in Canada. There are two main reasons. The vast majority of grassland that was the nesting habitat of prairie birds has been broken so management of remaining habitat becomes more vital to wildlife. The lack of market for grain and deterioration of prairie soils is leading to farmers being encouraged to convert cropland into forage.

Conversion to forage is certainly a positive step for wild birds because their productivity in croplands is extremely low (Milonski 1958, Rodenhouse and Best 1983, Cowardin et al. 1985) and cover provided by forage is very welcome. However, forage can be a trap that offers suitable cover and attracts nesting birds whose nests are then destroyed by forage harvest. The difference between a hayfield being highly productive for birds or a reproductive bust is often only a matter of days. The purpose of this session is to reacquaint people with the impacts of haying on birds and examine policy and haying practices. The goal is to find ways to encourage conversion of crop to forage and the management of forage to maximize avian productivity within the bounds of what is economic for agriculture.

The three papers in this session will outline current haying practices and policies and document decreased productivity in game and nongame birds occupying hayed habitats. The papers attempt to offer suggestions for changes in practice and policy that might benefit grassland birds. The remainder of the session will be used for discussing these suggestions and any that may be offered from the floor.

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EFFECTS OF HAYING ON WATERFOWL, UPLAND GAME BIRDS AND SHOREBIRDS

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The deleterious effects of haying on productivity of waterfowl, upland game birds, and, to some extent, shorebirds have been studied and I present a brief overview of their findings. I regret that this is a literature review but the waterfowl expert intended for this slot had to withdraw.

The effects of haying fall into two categories—the change it produces in the attractiveness of cover and the altered productivity of the birds that are attracted to nest in the hayed lands.

WATERFOWL

Numerous studies show undisturbed grass cover is more attractive to hens than areas with reduced residual vegetation (Evans and Wolfe 1967, Miller 1971, Oetting and Cassel 1971, Page and Cassel 1971, Elliott and Linder 1972, Kirsch et al. 1978, Voorhees and Cassel 1980, Livezey 1981). Haylands do not become attractive until some regrowth has occurred. The dates when sufficient cover is offered vary with plant species, location, weather, and duck species. In general, early nesters use hayfields for renests while late nesters use it for first attempts and renests (Milonski 1958, Gates 1965).

The negative impact of haying on productivity has been shown time after time (Labisky 1957, Gates 1965, Evans and Wolfe 1967, Elliott and Linder 1972, Cowardin et al. 1985). Many of these studies present simple success data uncorrected for different exposure times which results in an overestimate of success (Klett and Johnson 1982). Since success rates in hayed areas are low (maximum 22%) even without correction it is clear that, in general, haying precludes waterfowl attaining the minimum of 15% success (Mayfield adjusted) necessary to maintain stable populations (Cowardin et al. 1985).

Several studies have shown virtually every nest active at the time of haying is destroyed by mechanical means or immediate avian predation upon exposure at harvest time (Evans and Wolfe 1967, Labisky 1957). Losses of hens are not high (Milonski 1958, Cowardin et al. 1985). The cutting date is a critical factor in nest success in hayland and a two week delay caused for example by wet weather, can markedly increase nest success (Cowardin et al. 1985, Labisky 1957).

Rights-of-way are a special case. In areas of intensive agricultural activities, roadsides may be the only habitat with cover available to wildlife. There is also public land. Depending on local practices roadsides may be cut several times, cut later than hayfields, cut only some years, or not cut at all. Oetting and Cassel (1971) recognized wildlife agencies may be missing the boat if they do not utilize the potential of rights-of-way since they offer 20 million ha of habitat in the United States alone. Several studies have shown them to be very attractive to birds (Milonski 1958, Evans and Wolfe 1967, Oetting and Cassel 1971, Page and Cassel 1971, Higgins 1977, Voorhees and Cassel 1980, Klett and Johnson 1982, Cowardin et al. 1985). Success rates are higher in unmowed or late cut rights-of-way than in conventionally mowed areas. Their value is extremely variable depending on haying and predation impacts. Success varied from 3% to 83% in unmowed or delayed cut rights-of-way but was over 30% in most studies. The wider highway rights-of-way enjoyed, generally, better success than ditches along municipal roads. In one mowed right-of-way, success was lower at 15%.

Roadsides are linear habitat. They serve as travel lanes for mammalian predators so nests may be more vulnerable. If the roadway includes a fenceline productivity will be adversely affected also by avian predators (Milonski 1958, Evans and Wolfe 1967).

UPLAND GAME BIRDS

In general tame hayland does not seem very attractive to Greater Prairie Chicken (*Tympanuchus cupido*), Sharp-tailed Grouse (*T. phasianellus*), or Gray Partridge (*Perdix perdix*) since they prefer abundant residual cover (Kirsch et al. 1973, Kirsch et al. 1978, Smith et al. 1982, Church and Porter 1990). Greater Prairie Chicken and Sharp-tailed Grouse will use hayfields that have been idled or are cut every other year (Kirsch et al. 1973, Kirsch 1974). Native tall grass prairie requires some mowing to remain attractive to Greater Prairie Chicken in Minnesota (P. Buesseler, pers. comm.). Forty percent of Gray Partridge nest losses in Michigan were to farm machinery because Alfalfa (*Medicago sativa*) harvest coincided with the nesting peak (Yeatter 1932 *in* Leopold 1933). A third of nests in Saskatchewan tame hay were destroyed by haying but this was all nests active at the time of haying (Pepper 1972).

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Extensive research on the effects of haying on the Ring-necked Pheasant (*Phasianus colchicus*) has found hayed forage is less attractive to pheasants than undisturbed vegetation (Kirsh et al. 1978). Pheasants use hay forage mainly for renests (Dumke and Pils 1979). A South Dakota study found wild hay may be more attractive than tame forage (Trautman 1960).

As with waterfowl, reproductive success of upland game birds is higher in undisturbed than hayed tame forage habitat. Ten years of data from Illinois showed 13% of nests in mowed forage hatch while 35% hatch in unharvested forage (Warner and Etter 1989).

Most active nests are destroyed by hay harvesting (Dumke and Pils 1979, George et al. 1979). Pheasant hens are extremely vulnerable to injury and death from mowing equipment. An estimated 65% to 73% of sitting hens are hit by haying equipment (George et al. 1979, Warner and Etter 1989). The majority of hens struck die before the season is over.

Uncut roadsides are very attractive to game birds (Linder et al. 1960). Roadsides cut only once late in the summer are more attractive than ones cut two to three times (Warner et al. 1987). Rights-of-way can be productive especially if left undisturbed (Linder et al. 1960). Delaying harvest also improves productivity (Trautman 1960, Warner et al. 1987). However, predation rates in linear habitats were four times those in non-linear habitats (Haensly et al. 1987).

SHOREBIRDS

Studies of shorebirds on haylands are limited. Haylands and grazed pastures support roughly equal numbers of shorebirds (Kantrud 1981). Upland Sandpipers (*Bartramia longicauda*) definitely preferred areas with residual cover and chose idle grasslands or intermittently mowed road rights-of-way as a nest site much more often than pastures (Higgins et al. 1968). They are definitely vulnerable to mowing because nesting peaks in North Dakota are late June and mid-July (Higgins and Kirsch 1975). All Upland Sandpipers and Killdeer (*Charadrius vociferus*) nesting in unmowed rights-of-way were successful (Oetting and Cassel 1971). Two mower operators in Oregon estimated they killed between 400 and 600 birds, mainly shorebirds, in the period of 1 to 15 July (Braun et al. 1978).

SUGGESTED MANAGEMENT

Solutions proposed in the literature vary depending on land ownership.

Private Land

Since the benefits of delayed cuts have been established it is a desirable practice to see put into place on private lands. The North Dakota Wildlife Extension Program has put this into effect on limited acreage in that state (Stromstad and Donovan 1989). The Prairie CARE (Conservation of Agriculture, Resources and the Environment) program delivered by Ducks Unlimited subscribes farmers in Canada. Prairie CARE pays a fee per acre for hay to be cut only once per year, no earlier than July 15 and restricts other cover removal activities such as grazing and burning. My understanding is that this program is less popular where it would do the most good for wildlife—in areas where early and usually multiple cuts are common.

Several people suggested small tracts of bait cover left near hayfields, whether as a separate block or by leaving blocks of forage at the edge, would increase productivity of game birds (Leopold 1933, Warner and Etter 1989). Placement is important because the majority of game bird nests are found in the field perimeter (Labisky 1957). Early nesters would be attracted to bait cover because it has the most residual vegetation. Birds whose nests are destroyed by haying will be more liable to renest in bait cover than in the hay stubble. Bait cover blocks would take little land out of forage production but may substantially improve wild bird productivity. Leaving uncut blocks or strips could be promoted by wildlife agencies. To be most useful they should be at least several swaths wide and this will probably require subsidies. Encouraging farmers to leave small strips throughout the field would have some wildlife benefits. It should not require an economic incentive since it is sound agricultural practice recommended to forage producers. Strips of residual forage trap snow which insulates plants against winter damage and increases spring moisture which can boost yields by up to 50% (University of Saskatchewan 1987).

Set-aside-programs where government pays farmers to take tracts of land out of production have tremendous benefits for the period they are in force (Warner and Etter 1989). In Canada we have the Permanent Cover Program of Prairie Farm Rehabilitation Administration. It is not a wildlife program and has no restrictions on haying. The addition of wildlife guidelines to the Permanent Cover Programs could benefit nesting birds. The 1985 Food Security Act in the United States authorized a Conservation Reserve Program (CRP) that pays farmers to plant permanent cover on 11 million ha of erodible cropland (Hays et al. 1989). Regular haying is not allowed but widespread emergency haying was authorized during the 1988 drought. Mowing is allowed for weed suppression and during planting, and the majority of farmers surveyed said they mowed their CRP lands (Miller and Bromley 1989). Most allowable mowing occurs during the reproductive stage of pheasants (and most other nesting birds) which diminishes the potential benefit of the permanent cover (Hays et al. 1989, Warner and Etter 1989). A restriction on mowing CRP land would increase avian productivity. North Dakota's Wildlife Extension Program habitat set-aside that pays farmers to idle land was oversubscribed (Stromstad and Donovan 1989).

Other suggestions to modify mowing practices include leaving the middle of fields uncut overnight to allow dispersal of young birds herded into the residual by the mower (Leopold 1933), mowing from the inside to the outside (D. Fraser, pers. comm.), and leaving uncut islands around any nests farmers found. Labisky (1957) recommended large diamond shaped islands. The shape was easier for a farmer to leave and success in large islands of cover was high. Milonski (1958) pointed out it was impractical to expect farmers to leave substantial islands and that you should request what was more likely to be complied with. He asked farmers to leave a few inches around the nest or raise the cutting bar and pass over the nest. Fifty percent of nests in these tiny islands were successful. He felt predators were not particularly inclined to check out a little patch less than a m^2 in size that looked no different from places where the farmer just missed a bit.

If all farmers used recommended haying practices it might increase avian productivity. The Saskatchewan provincial guide suggests harvesting forage with a swather with conditioner attachment is preferable to mowing and raking because fewer leaves are lost (University of Saskatchewan 1987). From a wildlife perspective the swather results in fewer tire tracks and leaves nests between tracks undisturbed while raking is extremely destructive. Most farmers already own a swather and with increasing emphasis on hay quality minimizing leaf loss will be important.

Rights-of-Way

Tremendous benefits would be realized by delayed mowing of roadsides (Trautman 1960). A pilot program established suitable cover in Illinois ditches and obtained 90% farmer cooperation in not cutting ditches until August 1 (Joselyn and Tate 1972). Ditches showed increased pheasant productivity. North Dakota changed its roadside maintenance schedule and protocol and largely followed the recommendations of Oetting and Cassel (1971). They kept snow build-up within acceptable limits by mowing shoulders only. The state realized large cost savings from these changes and increased wildbird production.

In Saskatchewan, Rural Municipalities must mow ditches to collect certain provincial subsidies. The local landowner only has exclusive rights to hay in ditches until July 15. Some wildlife agencies in Canada have unsuccessfully attempted to influence management of this potential wildlife habitat. A restriction on haying prior to July 15 or a change allowing only shoulders to be cut could benefit birds.

Wildlife Lands

There are several options here. No haying at all is one solution (Trautman 1960, Kirsch et al. 1973, Braun et al. 1978, Livezey 1981). Delayed haying is another option that allows some revenue for the area while minimizing losses. However, Strassman (1987) found administrative costs necessary for permits were higher than revenue generated. Some authors feel periodic mowing is necessary to maintain waterfowl productivity levels (Voorhees and Cassel 1980). The amount of delay is a compromise that should be based on the species' peak of nesting and recovery rates of vegetation. Delaying harvest to September might save all nests but leave no time for vegetation recovery and offer little residual to birds the following year. Cutting too late may set plants back. The last option is a rotation haying system where only half the hayland is cut each year (Kirsch 1974).

ACKNOWLEDGMENTS

I thank James Lokken of Saskatchewan Soil Conservation Association for providing me with background information on haying practices and P.S. Taylor for his comments.

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PRODUCTIVITY OF ENDEMIC GRASSLAND PASSERINES IN HAYLANDS

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INTRODUCTION

Haying of native grassland and tame forage is a widespread agricultural practice and not uncommon on wildlife lands in Canada and the United States. Approximately 3.2 million hectares are sown to forage in the Canadian prairies with 11 million hectares harvested annually in the United States (Driver 1991, Frawley 1989). Cutting of tame forage occurs mainly in June and July, the peak of nesting for many birds. In the United States forage is commonly cut several times—in some places five times. In the Canadian prairies much of the hay is cut only once or twice. Three cuts are typical only with irrigation. No estimate was available for the amount of native grassland cut for hay. Native hay is usually harvested later in summer than tame forage. Studies of the effects of haying on birds, particularly nongame birds, are rarely conducted.

No Sprague's Pipit (*Anthus spragueii*) and very few Baird's Sparrows (*Ammodramus bairdii*) were found in surveys of hayed grasslands in North Dakota (Kantrud 1981). The number of species and individuals using Iowa alfalfa hayfields decreased significantly after mowing (Frawley and Best 1991). Individual species' responses varied but none showed a positive response. Upland nesting Red-winged Blackbirds (*Agelaius phoeniceus*) did not occupy hay habitats until two to four weeks later than old fields with residual vegetation. They deserted hayfields within 48 hours after mowing (Albers 1978).

Early in the century it was noted in Manitoba that native grassland, if hayed, was rendered unsuitable for Baird's Sparrow (Cartwright et al. 1937). More recently in Manitoba, singing bird surveys found Baird's Sparrows to be twice as abundant in idle grassland as hayland (de Smet and Conrad 1991).

Singing bird surveys at Last Mountain Lake, Saskatchewan found that although Savannah Sparrow (*Passerculus sandwichensis*) and Baird's Sparrow and Sprague's Pipit did use annually hayed tame forage, they were significantly less abundant than in undisturbed native areas (Dale 1990, 1991).

An Alberta study documented the negative impact of haying native fescue on bird numbers (Owens and Myres 1973). Baird's Sparrow and Western Meadowlarks (*Sturnella neglecta*) were absent from fescue hayed the previous year and Savannah Sparrow and Sprague's Pipit numbers were considerably reduced when compared to undisturbed fescue. Sprague's Pipit notably did not occupy hayed fescue until some regrowth occurred. It took three to four years for the area to become attractive to Baird's Sparrows (Wershler 1990).

The above studies are based on singing bird surveys which are not always a reliable indictor of a habitat's value to a species (Van Horne 1983). Habitats can attract birds but then fail to provide all the requirements for successful reproduction. Such habitats are termed ecological traps (Gates and Gysel 1978). To fully assess a habitat's value requires some measure of reproductive success.

The intent of this study was to: 1) compare reproductive success of grassland passerines in tame forage and idle native habitats, and 2) to determine if forage harvest affects avian productivity in haylands. Endemic grassland passerines, that have lost vast amounts of their former habitat, were the focus of this investigation. The research was conducted for the Canadian Wildlife Service (CWS) as part of implementing the North American Waterfowl Management Plan (NAWMP) on federal wildlife lands.

METHODS

The study was conducted in the Last Mountain Lake National Wildlife Area, Saskatchewan. Former farmland was seeded to tame forage in the late '60s and early '70s. Until recently it was made available to local farmers to cut for hay after July 1 with the provision

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that they must leave uncut strips. In 1991, the initial date for all cutting was delayed until July 15.

We monitored all nests of non-waterfowl species found by any means in 1990 and 1991. Most nests were discovered by chance when a parent flushed as we passed by while doing other work. Parents carrying food were followed, if possible, and some nests were found that way. A nest was classified as successful if at least one young fledged.

Nests of endemic passerines, particularly Baird's Sparrow, are difficult to find. A more indirect approach was tested in 1990 and applied in 1991. Parental behaviour for many passerines changes after they begin attending young: they carry food to the nest, carry feces away from it, and often change their alarm notes in a recognizable manner. It was therefore, possible to obtain an index of passerine productivity for cut forage and undisturbed native areas by visiting an equal number of plots of each habitat type for a fixed length of time (30 minutes) and recording instances of behaviours associated with brood care.

The index was conservative since one or many instances of brood care behaviour by a species in one field were scored the same. It is an index because we know we are unlikely to detect all productive birds but by spending the same length of time and searching the same area of each habitat we have a measure of productivity which we can compare between habitats. All comparisons were made with Fisher's Exact Test and $p < .05$ was used to establish significance.

RESULTS

Nests

The success rate in native grassland was significantly higher than in hayfields at $p = .10$ in 1990 (Table 1). There was no significant difference between nest success in either cover type in 1991, although the trend was the same as in 1990. The three successful nests in forage were not directly subjected to mowing. The single successful nest in 1990 fledged one day prior to mowing. The two passerine nests that succeeded in forage in 1991 were at field borders that remained unmowed.

Productivity Index

We conducted a preliminary study in 1990 but our methods were not well refined and the results therefore not testable. The 1990 results led to delaying the date for hay leases to July 15 in 1991 and more consistent sample data. However, in 1990 almost all observations indicative of productivity in cut hay were in an unraked field with sizeable uncut patches. Observed parental activity (alarm calls, food carrying, etc.) centred around unmowed portions of the hayfields.

In 1991, prior to haying (July 17 to 29), productivity was higher in native than forage areas for the three most abundant passerines and all species combined but differences were significant only for the latter (Table 2). After forage was cut (July 30 to August 5) the passerine community ("All Species") and Savannah Sparrow and Sprague's Pipit, in particular, were significantly more productive in native cover. The difference between hayfield productivity before and after cutting was significant only for "All Species" and the Savannah Sparrow. As in 1990 parental behaviour of care giving in cut forage was associated with unmown strips.

In summary, hayfields were not as productive for endemic grassland birds as natural habitats. Productivity noticeably declined in hayfield habitats after forage harvest even when haying was delayed to no earlier than July 15. Heavy rains in June 1991 shifted the nesting peak later into the breeding season which partially negated the benefit of delaying harvest until mid-July.

DISCUSSION

These findings are in agreement with the few studies conducted on productivity of nongame birds in harvested forage. Mowing may directly destroy nests or incubating birds. A study of haying and Bobolinks

Table 1. Number of nests in idle native and cut forage at Last Mountain Lake in 1990 and 1991.

	1990		1991	
	Successful	Failed	Successful	Failed
Native	9	2	7	3
Forage	1	4	2	3

Table 2. Number of fields showing productivity in native and forage vegetation before and after mowing at Last Mountain Lake in 1991.

	July 17-29		July 30-August 5	
	Native unmowed (N=12)	Forage before mowing (N=12)	Native unmowed (N=12)	Forage after mowing (N=12)
All species	12	7	11	2
Savannah Sparrow	10	6	7	0
Bairds's Sparrow	2	0	2	2
Sprague's Pipit	2	0	5	0

(*Dolichonyx oryzivorus*) in New York State found 51% of eggs and young in 33 known nests were destroyed during mowing and a further 10% during raking and baling (Bollinger et al. 1990). Mobile young were also vulnerable to the mower. Half of 20 fledglings known to be in the field prior to haying were found dead. In Iowa 100% of above ground nests and 50% of ground nests active at the time of mowing were destroyed (Frawley 1989).

Haying disturbs the parent(s) and removes much of the overhead cover from surviving nests which increases exposure to predators and weather. The New York study found 24% of Bobolink nests in mowed fields were deserted and 9% predated leaving only 6% of the original eggs or young to fledge (Bollinger et al. 1990). It is hard to imagine populations with such low nest success could sustain themselves. The Iowa study estimated productivity for hayfields of from .06 to 2.4 fledglings/territory for six species (Frawley 1989). These rates were well below the 3.3 to 6.7 fledglings necessary for a stable population (ibid.).

Mowing in native grassland may not be as immediately damaging as it is in tame forage but still has an effect. As Owens and Myres (1973) and Wershler (1990) showed in Alberta it may affect the mowed grasslands' attractiveness to birds in the following year or years. Mowing of native cover usually occurs later in the summer so that more birds would have a chance to raise a brood prior to cover removal. In many cases native grass is hayed in a more flexible manner with only the densest portions being harvested and some areas may not be cut every year. Native grasses provide much more dense cover near the ground than does tame forage (number of vegetative contacts in the first decimetre are four to seven times higher in native grass than tame forage). Consequently, there will be more cover to screen the nest from predators and the elements in cut native than cut tame forage. Although he has seen instances of mowing-related nest failure, Ken de Smet feels native hay in Manitoba can be productive in some years (pers. comm.). Recent casual observations of haying in fescue prairie near Little Fish Lake, Alberta show haying is sporadic and patchy. In general the area remains attractive to Baird's Sparrows and they are reasonably productive (C. Wershler, pers. comm.).

Hayfields, especially tame forage, would seem to be an ecological trap for some grassland passerines. Birds are drawn to fast growing cover in spring but productivity is reduced, especially when the nesting peak coincides with forage harvest. Early nesting species may get one brood off before a late June hay cut. Late nesting species may initiate nests and raise young after forage harvest (de Smet and Conrad 1991). The degree to which productivity is impacted by haying is related to local haying schedules, the nesting chronology of species involved, and weather conditions that cause shifts in either factor.

It is hoped that the study results can be applied by land managers to benefit wildlife, specifically endemic grassland birds, which require residual cover to successfully nest.

What can realistically be done to make haying and the welfare of wildbirds (both game and nongame) more compatible? There are two quite different potential areas to influence—private and public lands. There is more private land so changes in productivity, even small ones, are important. No change that causes economic loss to the landowner will be instituted without compensation. Public lands involve a much smaller area but account for most remaining large blocks of native habitat. Good management of them for wildlife is essential and may be easier to obtain so long as economic trade-offs are reasonable. Here are some possibilities.

1. Lobby for continuation of agricultural subsidies that encourage conversion of cropland to tame or native forage (Permanent Cover in Canada, Conservation Reserve Program in the United States). Low wildlife productivity on hayland is preferable to virtually no productivity on cropland. This alone is not enough. We also need to alter harvest conditions to increase avian productivity within haylands. Forage establishment programs are beneficial in terms of soil and water conservation and may take pressure off more critical habitats on public lands which are currently hayed.

2. Alter hay cutting schedules or policies where possible.

a) Wildlife lands - Encourage provincial and federal departments to adopt one of two policies for haying on wildlife lands. These are: defer cutting or don't allow cutting at all.

The majority of United States National Wildlife Refuges currently allow hay cutting prior to July 16 (Strassman 1987). As early as 1978, the Wilson Ornithological Society Conservation Committee (Braun et al. 1978) recommended haying of refuges should be delayed until August 1 to 15. Delaying until early August will increase success of waterfowl and endemic passerines. Frawley (1989) estimated delaying harvest until early August would allow 100% of potential productivity in southern locales. Endemic passerines sometimes nest well into August in Canada but delaying forage harvest further into August in the arid environment of the prairies would allow no time for regrowth and possibly damage plants. The lack of residual vegetation the next spring would make the area unattractive to wildlife or postpone nest initiation.

Where delaying into August will cause unacceptable losses in forage quality, the following compromise may be useful. Fields may be divided in half and the portions cut in alternate years no earlier than mid-July. Cutting half in any given year will provide some benefit through delay to the area cut and prevent losses to mowing in the portion left untouched. This uncut portion would have heavier residual cover in the following spring and attract the earliest nesters who could bring off young prior to cutting in mid-July. The portion cut in the previous year would not become attractive until later in the next breeding season but birds choosing to nest there would be undisturbed.

Strassman (1987) found haying fees charged by United States refuges were well below market price and revenue generated by hay leases did not cover administrative costs. Haying did not perform any habitat regeneration or improvement that could not be done just as well by burning. She admitted that some animals (Horned Larks [*Eremophila alpestris*], longspurs, some shorebirds) do prefer sparse or short vegetation but their habitat needs are met by conventional farmlands.

b) Rights-of-way - Lobby appropriate jurisdictions (i.e., highway departments and municipal governments) for placement of a date restriction on mowing public rights-of-way. In many cases ditches are cut to prevent drifting snow from blocking roads. Delaying the cut until late July would not interfere with this purpose but it might have a significant influence on nest success. In addition, it has been shown cutting only the shoulder is sufficient to prevent snow build up (Oetting and Cassel 1971).

c) Conventional farms - Promote conservation farming methods which include wildlife habitat considerations. Bryan and Best (1991) recommended haying of marginal cover in Iowa should be delayed until late August or even September. Frawley (1989) felt delaying forage harvest until late July would increase nesting success significantly but recognized it was not economically feasible to expect farmers to delay haying until most birds have raised their young. Hay quality declines as summer progresses. The Prairie CARE (Conservation of Agriculture, Resources and the Environment) program, delivered by Ducks Unlimited for the NAWMP, asks for postponement of cutting until July 15. This may be as good a type of compromise as can be expected on conventional farms. Frawley (1989) pointed out new haylands being created under agricultural programs and incentives could potentially have some hay date restrictions placed on them.

Another avenue to increased avian productivity is that wildlife agencies could promote leaving uncut blocks, strips, or patches in hayfields. Blocks or very wide strips may be a good alternative in regions where delayed cuts are unpopular. Strips leave some escape cover for fledglings and increase chances of survival for nests in the strip. Narrow strips also create a snow trap that promotes better soil moisture conservation and increases forage yields. The practice is encouraged by agricultural experts (University of Saskatchewan 1987). Strips near the edge are the most useful for gamebirds since most nests occur there. A qualifier to that is that strips near fencerows are less useful because posts are used by avian predators. The size of strip left greatly influences its usefulness. Narrow strips would trap some snow but provide little habitat and may act as travel lanes for predators. The application of the recommended harvesting technique of using a swather with conditioner (University of Saskatchewan 1987) creates less damage to the nesting environment than mowing and raking.

ACKNOWLEDGMENTS

This project is part of the NAWMP implementation program. It is funded by the CWS under an agreement with Wildlife Habitat Canada. I thank Dan Sawatzky for his able field assistance; James Lokken for considerable consultation on current policies; CWS staff P.S. Taylor, the project supervisor, for comments; and Clint Jorgenson for logistical support at Last Mountain Lake.

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HAYING AND GRASSLAND BIRDS: SUMMATION OF DISCUSSION

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A number of very practical aspects were pointed out by those attending the session. Leaving small strips is not acceptable to farmers using irrigation because the residual cover becomes sodden. An engineer expressed concerns about the ability of unmown ditches to transport water and wondered if leaving blocks at intervals would still help wildlife.

Discussion took place on the topic of quantity versus quality of hay. Where emphasis is on quality then early harvest is necessary and at odds with wildlife benefits. One attendee felt growing emphasis on quality could potentially increase conflict between agriculture and wildlife. Agricultural representatives frequently promote quality hay even where it is inappropriate. If a farmer is raising hay for his own beef animals it is in his best interest to harvest a large quantity of hay later in the season and shifting the emphasis to quality actually costs him money.

The question was raised about whether we should encourage forage production if it is likely to be an ecological trap. It was reemphasized that with management forage could be productive. We can discourage forage production and avoid the trap or we can try and change forage harvest strategies and not only avoid the trap but gain habitat.

A concern was raised that unmowed cover blocks or stretches of ditch may also be a trap because predators work edge habitat. It was restated that productivity gains did vary with ditch width and local predator situations. Widespread program application could result in considerable extra habitat making a predator's task more difficult. An attendee volunteered the information that in Minnesota they are protecting ditch cover and achieving gains in avian productivity. Manitoba is attempting to protect unused rights-of-way.

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GRAZING AND GRASSLAND BIRDS

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A number of studies have demonstrated that various grassland bird species differ in their tolerance to grazing on their breeding grounds. A good overview of the effects of grazing on breeding birds across the northern Great Plains can be found in Kantrud and Kologiski (1982). In the mixed grassland of Alberta (C. Wershler, personal field notes) the following generalized habitat preferences, with respect to grazing intensity, have been noted for the following species: lightly grazed habitats with Baird's Sparrow (*Ammodramus bairdii*), Grasshopper Sparrow (*A. savannarum*), and Sharp-tailed Grouse (*Tympanuchus phasianellus*); lightly to moderately grazed grassland with Sprague's Pipit (*Anthus spragueii*) and Western Meadowlark (*Sturnella neglecta*); moderately grazed grassland with Long-billed Curlew (*Numenius americanus*); moderately to heavily grazed grassland with Chestnut-collared Longspur (*Calcarius ornatus*); heavily grazed grassland with Horned Lark (*Eremophila alpestris*), McCown's Longspur (*Calcarius mccownii*), and Mountain Plover (*Charadrius montanus*). Species that prefer lightly grazed or lightly to moderately grazed habitats also occur in ungrazed grassland. These preferences mostly conform with the findings of Kantrud and Kologiski (1982).

The conservation of species diversity in grassland birds, therefore, requires the maintenance of a range of habitats, from lush grassland in idle or lightly grazed areas to shortgrass conditions in heavily grazed areas. However, all bird species exhibit some degree of variability in their tolerance to grazing, related to the following: differences in soil/vegetation type across the breeding range, climatic fluctuations, and types of grazing systems (differences in duration, frequency, and timing of grazing). For example, light grazing in upland fescue grassland with rich, well-drained soil may result in prime nesting habitat for Baird's Sparrows, while similar grazing in mixed grassland with solonetzic soil may be only marginally productive. In order to develop a strategy for habitat diversity in a particular natural region, it is important to have a basic understanding of the habitat potential for various species in the region and the effects of grazing on the various soils and vegetation types within the region.

In some cases, the management of grazing for a diversity of habitats may actually be detrimental to overall ecosystem diversity. Certain habitat types in specific regions require grazing prescriptions that will create or maintain homogeneous/extreme conditions to maximize productivity for rare and significant ecosystem features. For example, heavy grazing may be required in specific mixed grassland habitats that have high potential for the rare Mountain Plover (Wershler 1991), Richardson's Ground Squirrels (*Spermophilus richardsonii*), and birds of prey; light grazing in these habitats limits their potential for these species. Conversely, no grazing or light, infrequent, late-season grazing is required to maintain lush fescue grassland, an endangered ecosystem. The intensive grazing that occurs in the majority of fescue grassland today severely limits the potential of this habitat for species of birds (e.g., Baird's Sparrow) and plants characteristic of lush fescue grassland (Wershler and Wallis 1990).

Although grassland bird communities evolved with grazing animals, the replacement of the American Bison (*Bison bison*) with cattle, as the dominant grazer, has resulted in habitat changes related to the following:

1. Cattle have different grazing preferences than bison when grazed in the similar habitats for similar periods (Peden et al. 1974, Schwartz and Ellis 1981).
2. Bison grazed over expansive areas of grassland, following traditional seasonal patterns of use. Today's rangelands are, by comparison, very small and are often grazed with the aid of fencing, artificial stock watering areas, salting, and supplemental feeding. In recent decades, there has been a trend in the last remaining tracts of native grassland toward smaller pastures and more intensive management practices.
3. Good range management for domestic livestock production (i.e., maximizing livestock production without adversely affecting range condition) maintains habitat for numerous bird species, but is inadequate for the conservation of the diversity of bird life, including species that require the extremes in range condition (heavily grazed or lush grasslands).

Other changes that have occurred in the grasslands since pre-settlement days, including the suppression of fires and declines in Richardson's Ground Squirrel populations (Wershler 1991), may have had significant impacts on habitats and bird communities. Although, the exact role of fire in Mixed Grassland Ecosystems is not well understood, fire appears to have been a regularly occurring natural phenomenon during dry seasons and drought periods throughout the grasslands of North America (Vogl 1974, Wright and Bailey 1980). Recently burned areas are known to attract grazing animals and certain bird species, including the rare Mountain Plover (Wershler 1991). Fire also results in the re-cycling of nutrients, in seed dispersal for numerous plant species, and in limiting the spread of woody plants.

As with fire, the relationships of Richardson's Ground Squirrels to other components of the mixed grassland have not been well-documented. This species thrives locally in more heavily grazed grassland. As a major food source for Ferruginous Hawks (*Buteo regalis*) and other raptorial birds, ground squirrels must be considered as a key element of the habitat for these predators. In addition, the activities of ground squirrels contribute to ecosystem diversity by providing burrows for numerous species of animals, by influencing vegetative composition, and by providing a valuable food source for predacious mammals and reptiles.

A better understanding of the interrelationships of grazing, fires, and ground squirrel populations, and the role of these factors in the creation and maintenance of biodiversity in the grasslands would provide useful information for the management of birds and other ecosystem components.

MANAGEMENT RECOMMENDATIONS

1. Compared with other animal groups, breeding birds are relatively easy to observe and identify. Surveys of breeding birds in the grasslands can provide a good index of biodiversity and habitat productivity. Utilizing this approach, research should be carried out into the effects of various grazing systems on populations of grassland birds. This should include: 1) research in representative major habitats of the various natural regions so that appropriate range management guidelines can be developed for a given ecotype, and 2) work in specific areas (e.g., protected areas) to monitor the effectiveness of prescribed management.

2. Ideally, this research should involve the long-term monitoring of the relative abundance and composition of bird populations—this would provide valuable insight into natural population variability, which would be of value in the application and assessment of management strategies.

3. Although management practices for the maintenance of avian diversity will generally benefit other groups of animals and plants, studies specific to these groups are needed in order to identify the range of management requirements for the conservation of their biodiversity.

4. These types of studies should be initiated on Crown lands (e.g., protected areas, grazing reserves) and special management areas where the largest remnants of relatively undisturbed native grassland generally exist, and where there is often a clear mandate for the maintenance of biodiversity.

5. Investigations should be undertaken on bison versus cattle grazing, the role of fire, and the role and status of ground squirrels in the grassland ecosystem.

6. Significant ecosystem components (e.g., major ground squirrel-raptor associations) and critical habitats for rare species should be identified and management strategies developed to optimize the potential of these special areas.

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GRASSLAND REQUIREMENTS BY FERRUGINOUS HAWKS

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As its distribution on the great plains of North America attests, the Ferruginous Hawk (*Buteo regalis*) is an open country raptor. Below is a summary of observations which describe this hawk's response to changes in habitat, changes in prey densities, and potential competition with other raptors. I will focus the discussion on populations inhabiting the broadly classified "grassland" ecosystem east of the Rocky Mountains. Populations west of the Rocky Mountains may have different ecological requirements (Schmutz and Fyfe 1987, Schmutz et al. 1990).

HABITAT

Since settlement of the Canadian prairies, two major changes in habitat have occurred; the expansion of parkland into prairie habitat and the cultivation of interspersed grassland. Both have affected Ferruginous Hawks negatively.

The departure on the part of Ferruginous Hawks from approximately 50% of their former breeding range in Canada correlates with an expansion of trees from the adjacent parkland. While Ferruginous Hawks prefer elevated sites including trees for nesting (Schmutz et al. 1988), the hawks are uncommon in extensively treed areas. The expansion of parkland habitat following a reduction in prairie fires after settlement (Vogl 1974) has permitted Red-tailed (*Buteo jamaicensis*; Houston and Bechard 1983) and Swainson's Hawks (*B. swainsoni*) to expand into areas formerly occupied by Ferruginous Hawks.

A link between breeding density of Ferruginous Hawks and grassland has long been demonstrated (see Schmutz 1984, for additional references). However, agricultural cultivation has not been detrimental to Ferruginous Hawks in all cases. A study of Ferruginous Hawk breeding density on 76 randomly selected 41 km^2 study plots in southeastern Alberta in 1982 and 1987, showed a statistically significant increase in breeding density when plots with 0-10% cultivation were compared with plots between 11-30% cultivation (Schmutz 1989). However, when the extent of cultivation exceeded 50%, breeding density declined steadily.

PREY USE

The initial increase and subsequent decline by Ferruginous Hawks in response to increased cultivation on plots was probably mediated by Richardson's Ground Squirrels (*Spermophilus richardsonii*). Ground squirrel abundance in relation to cultivation showed a pattern similar to Ferruginous Hawk abundance (Schmutz 1989). This link between predator and prey is consistent with evidence that showed a close correlation between ground squirrel and Ferruginous Hawk abundance over a 9-year period on a study area near Hanna, Alberta (Schmutz and Hungle 1989). More ground squirrels also led to more young Ferruginous Hawks being raised to fledging.

Interestingly, the density of Ferruginous Hawks wintering in northwestern Texas was not correlated with the extent of cultivation. Ferruginous Hawks there apparently relied on Black-tailed Prairie Dogs (*Cynomys ludovicianus*; Schmutz 1987, Schmutz and Fyfe 1987), as they do in some other areas (Cully 1991, Treviño-Villareal 1990). Due to their colonial nature, many prairie dogs often frequented small parcels of uncultivated land where the prairie dogs were able to persist in otherwise extensively cultivated regions despite eradication campaigns. These and the results obtained in Alberta suggest that it is not agricultural cultivation per se that affects Ferruginous Hawks negatively. Instead, cultivation lowers prey densities and thereby causes a decline in the abundance of Ferruginous Hawks.

Although other buteonine hawks have ecological requirements similar to Ferruginous Hawks, these, notably Swainson's Hawks, did not decline as more land was cultivated (Schmutz 1989). Swainson's and Red-tailed Hawks were apparently able to shift to other prey after ground squirrels disappeared in extensively cultivated regions. Ferruginous Hawks in contrast appear to be ground squirrel specialists and are hence vulnerable to changes in habitat and prey abundance.

COMPETITION

In some cases where Ferruginous Hawks have nested in close proximity to other buteos, Ferruginous Hawks have come into conflict. The aggressive Swainson's Hawks have attacked (Restani 1991) and sometimes evicted Ferruginous Hawks (Schmutz et al. 1980) from their nests when nest sites where in short supply. However, if competition for space existed in some instances this did not appear to affect Ferruginous Hawk distribution overall. Based on 76 study plots in Alberta, there was no evidence that Ferruginous Hawks were low in numbers when Swainson's Hawk were abundant (Schmutz 1989).

RECOMMENDATIONS

Ferruginous Hawk's are remarkably flexible in their choice of nest sites using trees or ground sites where possible as availability dictates. However, the Ferruginous Hawk's dependence on grassland and the ground squirrels and prairie dogs that exist there, has important implications for this species' conservation. Because of their adaptation for the arid prairie environment, Ferruginous Hawks are able to cope with the normal fluctuations in ground squirrel abundance, and with heat and hail. However, these same specializations make this species vulnerable to changes.

Ferruginous Hawks are generally common where a ranching land use prevails. The low level cultivation that is practised by ranchers presents little if any problem and ground squirrels are generally tolerated in rangeland. As long as this type of land use persists on the breeding ground in Canada, along the migration pathway and in the wintering area, there is considerable assurance that Ferruginous Hawks will grace the Canadian prairies for many years to come.

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TOXICOLOGY OF PESTICIDES IN PRAIRIE CANADA: PROGRESS AND FUTURE DIRECTIONS

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Canada has an impressive record of risk assessment and investigation into the effects of agricultural pesticides on prairie flora and fauna. This review covers most of the work that has been done relative to environmental effects in this region, but it barely touches on the important subject of environmental chemistry (partitioning and degradation), for which a large body of information exists, at least for aquatic systems, due to the excellent research program of the Freshwater Institute in Winnipeg. Recommendations for further work include action items resulting from the discussions that followed the three papers presented in the toxicology session, published in these proceedings, and priorities identified by several working groups of environmental toxicologists and chemists.

CURRENT INFORMATION

Potential effects of pesticides on waterfowl have constituted the topic of greatest concern for the past 10 years. All currently available data were very thoroughly reviewed by the Canadian Wildlife Service (CWS) to evaluate the degree of overlap between waterfowl habitat and crop production, the extent of pesticide use for various types of crops, and the potential effects of herbicides on terrestrial and aquatic vegetation and invertebrates, and of insecticides on waterfowl and their invertebrate food resource (Sheehan et al. 1987). These concerns have been summarized (Mineau et al. 1987) and updated (Forsyth 1989, 1991). Studies of the toxicity of carbofuran (Furadan) insecticide to Mallard ducklings (*Anas platyrhynchos*) have shown that daily dosing with sublethal but relatively high doses caused delayed fledging (Martin et al. 1991a). Single sublethal doses impaired thermoregulatory ability (Martin and Solomon 1991) and walking 150 m through carbofuran-sprayed vegetation was not lethal, but caused signs of intoxication and inhibition of approach-response behavior towards other ducklings (Martin et al. 1991b). Further studies of the impact of carbofuran-sprayed vegetation on ducklings showed that effects were negligible unless feeding on sprayed material occurred during the walk with a hen duck (Martin and Forsyth, in press). Carbofuran sprayed on prairie ponds to simulate aerial application for grasshopper control resulted in significant mortality of caged aquatic invertebrates (Wayland and Boag 1990) and over 90% loss of Freshwater Shrimp (*Hyalella azteca*) biomass, and 83% loss of chironomid larvae biomass (Wayland 1991).

The synthetic pyrethroid insecticides, permethrin, cypermethrin, deltamethrin, and fenvalerate, are highly toxic to aquatic invertebrates; hence, their persistence and effects in prairie ponds are of concern due to the likelihood of direct application to ponds by aircraft spraying of crops. Deltamethrin (Decis®) degrades rapidly in water, and is partitioned into organic matter; intact deltamethrin remained at 3-5 ng/g in sediment 305 days after treatment of small research ponds with acetone solutions of insecticide (Muir et al. 1985a). It should be noted, however, that deltamethrin persistence in sediment was not found in ponds sprayed by aircraft, probably due to the concentration of material in the surface layer of water, followed by volatilization (Muir et al. 1992). Aerial application of deltamethrin to prairie ponds at the rate used on crops resulted in a 99% kill of chironomid larvae, and Mallard ducklings on the treated ponds stopped gaining weight and some died, whereas growth of control ducklings was unimpeded (Morrill and Neal 1990). Chironomid larvae concentrated pyrethroids during 24 hours of exposure to sediments containing 5 ng/g without apparent harmful effects (Muir et al. 1985b). Whether or not longer periods of exposure might have proven harmful has not been determined. Laboratory studies with permethrin demonstrated that sediment contaminated by application to water at the rate registered for insect control caused 100% mortality of mayfly nymphs (*Hexagenia rigida*), eight days after application (Friesen et al. 1983).

Effects of herbicides in prairie ponds have received very little study. Productivity of periphytic algae in marsh enclosures was reduced 90% by addition of terbutryn to the water at 0.01 mg/l, but was not affected by simazine at 0.1 mg/l (Goldsborough and Robinson 1983). Spray application of bromoxynil esters (Torch DS formulation) to the surface of experimental ponds at the Delta marsh in Manitoba resulted in mortality of caged Brook Stickleback (*Culaea inconstans*) and

Freshwater Shrimp when concentrations in the water were at least 2.1-5.8 µg/L and 35-64 µg/L, respectively. Resident populations of Freshwater Shrimp did not exhibit mortality, however, whereas resident sticklebacks disappeared (Muir et al. 1991). Submerged macrophytes in pond enclosures exhibited a dose-dependent response in growth and survival when 2,4-D, picloram or clopyralid was added to the water in concentrations of 0.01 or 0.1 mg/litre (Forsyth et al., in press). A study of the effect of glyphosate (Roundup formulation) on productivity of phytoplankton in ponds has been completed by the Inland Waters Directorate, Environment Canada, Regina (P. Shaw), and the uptake and effects of triallate in *H. azteca* are being investigated by the National Hydrology Research Institute (M. Arts).

Application of glyphosate (Roundup®) or sethoxydim (Poast®) to the eggs of domestic chickens did not reduce hatchability, indicating that the use of these herbicides in zero tillage farming should not be hazardous to the eggs of upland-nesting galliforms or waterfowl (Batt et al. 1980, Wayland et al. 1987). The insecticides, carbofuran, chlorpyrifos, and deltamethrin, were similarly low in toxicity to Japanese Quail eggs (*Coturnix japonica*); however, further testing may be required on eggs of more sensitive species (Martin 1990). Japanese Quail, Ring-necked Pheasant (*Phasianus colchicus*), and Savannah Sparrow (*Passerculus sandwichensis*) provided with dimethoate-treated bran bait scattered on cage floors at the rate used for grasshopper control did not undergo measurable depression of brain cholinesterase after 24 hours of exposure (Radvanyi et al. 1986). Direct overspraying of Burrowing Owl (*Athene cunicularia*) nest burrows with carbofuran for grasshopper control resulted in reductions of 83% in brood size and 82% in nest success, whereas carbaryl (Sevin®) and chlorpyrifos (Lorsban®) had no effect (Fox et al. 1989). Penned pheasant chicks, seven weeks old, exposed for five days to scattered grain sprayed on the first day with carbofuran at the rate used for grasshopper control were not adversely affected (Somers et al. 1991a). Similarly, pheasant and Chukar (*Alectoris chukar*) chicks four days old were not affected in weight gain or brain cholinesterase activity by direct spray application of carbofuran, carbaryl, or dimethoate (Somers et al. 1991b). Carbofuran applied by aircraft at the rate of 140 g active ingredient per hectare to a square mile of pasture in Saskatchewan resulted in no discernible effects on small mammal abundance and did not cause signs of overt toxicity in songbirds, although brain cholinesterase activity was significantly depressed and fledging success was almost 40% less than that of birds in a control pasture (Irvine 1987). Availability to wildlife of carbofuran in vegetation and grasshoppers was also documented (Forsyth and Westcott, manuscript submitted). Captive Clay-colored Sparrows (*Spizella pallida*) demonstrated a preference for dead over live grasshoppers in prey selection trials, and were not made sick by eating grasshoppers sprayed at the rate used in the field as their sole source of food for one day (Forsyth et al., manuscript submitted). Granular carbofuran is highly toxic to songbirds, is commonly deposited on the surface of soil during seeding, and was the cause of one very large kill of migrating Lapland Longspurs (*Calcarius lapponicus*) documented in Saskatchewan (Mineau 1988). Preliminary results of the Prairie Nestbox Monitoring Program (Horstman et al., this volume), indicate that some insecticides may be causing abandonment of nests by Mountain Bluebirds (*Sialia currucoides*) and Tree Swallows (*Tachycineta bicolor*). Survival, measured as trappability of tagged young Deer Mice (*Peromyscus maniculatus*) and Meadow Voles (*Microtus pennsylvanicus*) of all ages in grassland sprayed with carbofuran for grasshopper control was 40% and 33%, respectively, less than that of unsprayed populations (Brusnyk and Westworth 1987).

American Kestrels (*Falco sparverius*) fed one chlorophacinone-killed mouse per day for 21 days behaved normally and survived the treatment, although haemorrhaging was evident. The authors concluded that wild kestrels might suffer lethal effects of this rodenticide if they ate more than one poisoned mouse per day for more than 21 days (Radvanyi et al. 1988). Nestling Swainson's Hawk (*Buteo swainsoni*) that consumed ground squirrels poisoned by strychnine, but with stomachs removed to eliminate poisoned grain, did not exhibit adverse effects on growth or survival (Schmutz et al. 1989). Reproduction and survival of Burrowing Owls were also not affected by Strychnine poisoning of ground squirrels in the close vicinity of nest burrows (James et al. 1990).

INTEGRATION OF AGRICULTURE AND WILDLIFE

Attainment of the goal of sustainable crop production that conserves wildlife populations within the agricultural landscape requires improved understanding of the effects of pesticides in ecosystems and communication of information to farmers. The discussion following the toxicology session generated two very relevant action items: (a) Multidisciplinary controlled field studies at the ecosystem level should be undertaken to determine the fate and effects of major-use pesticides in terrestrial and aquatic systems, and (b) Information on the environmental hazards of, and alternatives to, pesticides, should be provided to farmers to facilitate their modification of traditional approaches to production. The first of these recommendations is also a stated objective of the Canadian Network of Toxicology Centres, supported by the Green Plan of the Government of Canada. Therefore, efforts will be made to focus the expertise available in the prairie region and elsewhere in Canada on field studies designed to establish how various organisms are exposed, the extent of effects on behavior, reproduction and survival, and methods for extrapolating from laboratory studies to the field. The second recommendation will be addressed by a series of pamphlets, currently being prepared by the CWS, which will outline hazards of pesticides to wildlife for farmers and will further be addressed by the Pest Management Alternatives Office, a 1992 Green Plan initiative of the federal government, that will promote alternatives to chemical pesticides, stimulate and fund research, and maintain a computerized information base.

Some of the priorities for research identified by working groups of a workshop sponsored by the Society of Environmental Toxicology and Chemistry are: field validation of risk assessment procedures, development of ecologically significant endpoints for effects assessment, bioavailability of chemicals from sediments, prediction of ecosystem stress from controlled laboratory and field investigations, sublethal effects of chemicals in aquatic organisms, factors affecting exposure of terrestrial organisms to toxins, identification of sentinel species, influence of sensory detection on exposure, comparative biochemistry and physiology, behavioral toxicology, and effects at the population, community, and ecosystem levels. The Avian Effects Dialogue Group identified needs for selection of potential focal (sentinel) species of bird in various crop areas, development of pesticide sensitivity data for focal species in the laboratory, testing their response to pesticides in the field, establishment of a network of field reporters from various segments of society to monitor incidents of pesticide poisoning of birds, and development of models to predict effects of pesticides on birds. These lists are only partial; for additional priorities and details of the rationale for each, see Anonymous (1987, 1991).

The foregoing action items and priorities are consistent with the data gaps identified by Sheehan et al. (1987) and with the ongoing program of research and monitoring of the CWS and collaborating scientists. Initiatives are underway to assess pesticide effects and benefits of alternative agricultural practices by comparing avifaunal diversity and abundance on organic versus conventional farms (Rogers and Freemark 1991) and establishing long-term multidisciplinary studies of wildlife-agriculture interactions with cooperating landowners. Similar projects in Britain (Jarvis 1988), Denmark (Brae and Petersen 1988) and the Netherlands (deSnoo and Canters 1988) will serve as models.

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PESTICIDES AND WILDLIFE IN THE PRAIRIES: CURRENT REGULATORY ISSUES

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INTRODUCTION

The agricultural landscape of the Canadian prairies covers most of the southern third of Alberta, Saskatchewan and Manitoba. Within this large area of extensive agriculture are found remnants of wildlife habitat dispersed within and around cultivated fields. These habitats consist of woodlots, shelterbelts, ditches, coulees, isolated plots of grassland, and wetlands, all essential to the maintenance of healthy wildlife populations in the prairies. This region is also known for the extensive use of farm chemicals which can pose a serious threat to this resource. Sales of insecticides and herbicides in the three prairie provinces accounted for 48% and 67% respectively of total Canadian sales in 1986 (Environment Canada/Agriculture Canada 1987).

Because of this extensive overlap between wildlife habitat and agrochemical use, the Canadian Wildlife Service (CWS), as an advisor to Agriculture Canada (AC) on the effects of pesticides on wildlife, has focused much of its attention on this region. As a participant in the pesticide regulatory process, CWS has an input to the regulatory decisions which can encompass approval or denial of new registrations, modification of labels, use restrictions or even cancellation of existing registrations. To illustrate part of the process of evaluation of the impact of pesticides on wildlife, three issues of concern to CWS are discussed. The focus of the discussions are on the origin of the concern, the studies conducted to determine the extent of the risk, and finally, the regulatory actions which were taken or have been proposed.

THE BURROWING OWL

The Burrowing Owl (*Athene cunicularia*) is a small owl of the western prairies and British Columbia interior which nests in abandoned mammal burrows and which feeds extensively on small mammals, grasshoppers and other insects. The Canadian population of Burrowing Owl has undergone a sharp decline in the last 20 years (Fox et al. 1989). Between 1976 and 1987, the number of breeding pairs in South-central Saskatchewan fell by 50%; in Manitoba, numbers fell from 76 pairs in 1982 to 15 in 1987. In 1979 the Burrowing Owl was designated as a threatened species by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).

Evidence had indicated that in three districts in Alberta owls had not been seen since most farms were sprayed with insecticides to control severe grasshopper infestations in 1974 and 1975 (Wedgwood 1978). In 1985 approximately 3 million hectares were sprayed in Saskatchewan to control grasshoppers, 40% of which was carried out using carbofuran, an insecticide extremely toxic to birds. Because much of the preferred habitat of the owls coincides with cropland cultivated for cereal and forage, the CWS commissioned a study of the impact of grasshopper insecticide sprays on this threatened species.

The impact of operational grasshopper control on Burrowing Owls was studied in 1986 and 1987 at three sites in Saskatchewan (Fox et al. 1989). The studies showed that carbofuran had a significant impact on the survival and the reproductive success of the owls when sprayed over the nest burrows: brood size and nesting success were reduced respectively by 83% and 82% when compared to a control group. Secondly, reproductive success decreased with increasing proximity of the exposure to the burrow. Furthermore, a survey of landowners on the study areas suggested that the number of active nests in 1987 was significantly smaller on lands which had been sprayed for grasshoppers with carbofuran in 1985 or 1986 than on lands sprayed with other insecticides during the same period. The authors of the study concluded that the impact of carbofuran was a result of its toxicity rather than food removal and that, in spite of few data, at least two other insecticides, carbaryl and deltamethrin, did not cause similar effects.

Subsequent to this study, Environment Canada (EC) recommended to AC that extensive geographic restrictions be put on the use of carbofuran formulated as FURADAN 480F^{TM} in order to protect the Burrowing Owl. The compromise reached between the two departments was a restriction, implemented as a supplementary label, which prohibits the use of FURADAN

480F$^{\text{TM}}$ within a minimum of 250 m of an occupied Burrowing Owl burrow.

The effectiveness of such a regulatory action is dependant on the information about the restriction reaching landowners and pesticide users. An information campaign was launched in 1990 through the distribution of pamphlets and radio advertising to raise awareness of the issue and the restrictions. A survey of 115 landowners registered with "Operation Burrowing Owl" in 1990 indicated that 50% were aware of the restrictions. A similar survey the following year indicated that 70% of 124 landowners were now aware of the restrictions. The true effectiveness of this regulatory action will only be properly assessed in years of severe grasshopper infestations when landowners are confronted with a significant pest control problem.

GRANULAR FORMULATIONS OF CARBOFURAN

In June 1989, AC announced the re-evaluation of all uses of flowable and granular formulations of carbofuran because of EC's concerns about its potential impact on birds. The concern originates from the extreme toxicity of carbofuran, a carbamate insecticide, to a broad range of species. The acute toxicity of this insecticide, as determined by the laboratory-derived LD$_{50}$, is below 1 mg/kg for two waterfowl species tested as well as some songbird species (Eisler 1985). Between 1986 and 1990, 109 reported bird kills that included over 70 different species in North America, were attributed to carbofuran poisoning. Among these were numerous eagles, hawks, vultures, and other birds of prey which received a lethal dose while feeding on contaminated waterfowl and songbird carcasses. These secondary poisonings suggest that a large amount of carbofuran-induced mortality goes undetected by the authorities but not by the local raptor and scavenger populations. Although EC's concern regards both formulations, only the case against the granular, as it relates to the Canadian prairies, will be discussed here.

Two granular formulations of carbofuran are registered for use in western Canada; FURADAN 5G$^{\text{TM}}$ and FURADAN CR-10$^{\text{TM}}$ are registered for use on canola and mustard at planting for the prophylactic control of flea beetles. Only the latter is in current use. Granular insecticides are incorporated into the soil at the time of seeding. Much of the concern with granular formulations comes from their similarity, both in size and shape, with grit consumed by birds. In the case of FURADAN, the dose of carbofuran contained in one CR-10 granule is enough to kill a small- to medium-bodied bird. In one reported bird kill at Vonda, Saskatchewan, in 1984, it is estimated that well over two thousand Lapland Longspurs (*Calcarius lapponicus*) were killed after a quarter section of canola was treated with FURADAN CR-10$^{\text{TM}}$ (CWS 1992).

Granular insecticides are used over extensive areas of the northern prairies. Estimates range from 0.37 to 0.54 million hectares treated yearly between 1981 and 1985. Peak seeding for canola occurs in mid-May when the largest flocks of migratory birds move across the prairies. Of particular concern are those species which migrate in large flocks and use open agricultural land for foraging such as longspurs, Horned Larks (*Eremophila alpestris*), or buntings. Such flocks commonly consist of as many as 10,000 birds which may cover an entire quarter section. It is therefore, our concern that a few incidents such as the one observed in Saskatchewan in 1984 could have serious consequences for the populations of some of these species.

Table 1. Proportion of surface-visible granules in field crops (from Maze et al. 1991).

Seeding Implement	Fallow (%)	Stubble (%)	Surface count[a] (per hectare)	Popularity of seeding implement
Press drill	5.30	4.70	66,300	high
Hoe drill	0.74	0.37	9,100	low
Air seeder[b]	0.31	0.92	3,800	low
Air seeder (broadcast)	4.20	2.20	52,500	low

[a] Based on proportions obtained on fallow

[b] Either type of application was followed by a harrow-packing operation

EC sponsored an engineering study to determine the availability of granules to birds following incorporation into the soil (Maze et al. 1991). The highest average surface residues were 5.3% of the amounts applied with a press drill or approximately 7 granules/m^2 (Table 1). Hot spots were encountered with counts as high as 33 granules/m^2. It is important to note that the kill reported in Saskatchewan in 1984 occurred following the application of the granules with an air seeder used to broadcast the seed, followed by a harrow/packer. According to Table 1, this is not the most popular seeding implement but, more importantly, it leaves fewer granules on the surface than the more popular press drill. This evidence suggests that the availability of granules to birds is high and that the potential exposure to the insecticide is of great concern.

The case against carbofuran as assembled by EC is now before AC and a regulatory decision is pending. In the United States, the Environmental Protection Agency (EPA) negotiated a settlement with the manufacturer to withdraw all but five very minor uses of granular carbofuran since "none of the risk reduction measures [evaluated by the EPA] were adequate to reduce the risk to birds, given the high toxicity of carbofuran granules." Furthermore, the State of Virginia recently conducted an extensive survey which showed that bird kills were found in every planted field despite such drastic risk reduction measures as wide buffer zones on the edges of fields, devices to shut off granule flow in turn areas or extensive training programs for the applicators. A complete ban on carbofuran granulars is now in effect in that state.

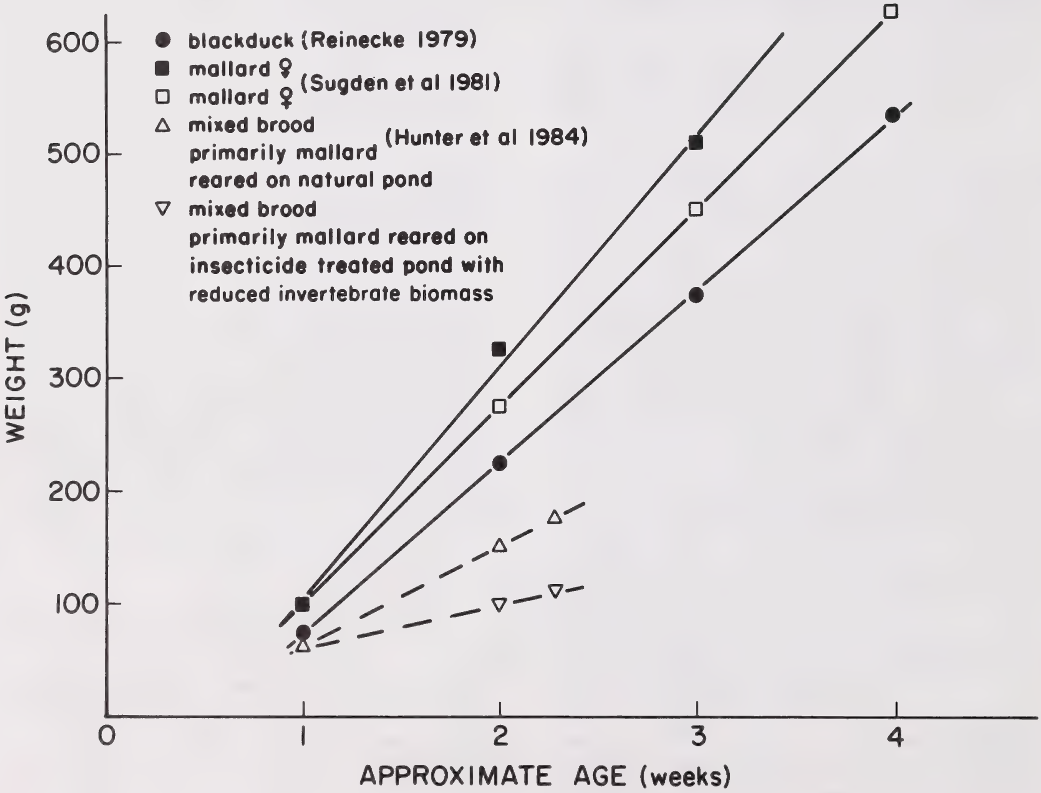

Figure 1. Growth of Black Duck (*Anas rubripes*) and Mallard (*A. platyrhynchos*) ducklings during weeks one through four of age. Optimal growth rates for laboratory reared birds (Reinecke 1979 and Sugden et al. 1981) are compared to those of experimental broods reared in natural habitats both treated and untreated with the insecticide carbaryl (from Sheehan et al. 1987).

AERIAL APPLICATION OF INSECTICIDES IN THE PRAIRIE POTHOLE REGION

Our concern regarding the aerial application of insecticides in the prairie pothole region centres around the potential reduction in the invertebrate food supply of laying hens and ducklings when wetlands are contaminated by insecticide drift or overspray. We argue that in this type of wetland environment, where average wetland densities can reach 28/km^2 or more, covering as much as 20% of the land area (National Wetlands Working Group, 1988), even under the best application conditions, contamination of a significant level is likely (Sheehan et al. 1987). The prairie pothole region overlaps large parts of the prairie agricultural region and, thus, the wetlands are surrounded by cultivated fields.

Waterfowl depend on the rich and productive aquatic invertebrate populations of prairie wetlands during critical periods in their life cycle. Female ducks require a diet rich in protein and calcium for egg laying. Ducklings of all species require a diet rich in protein in the first few weeks after hatching for rapid growth. This is essential for surviving predation and extremes in temperature typical of prairie springs. Both for the hen and the ducklings, this diet rich in protein and calcium originates for the most part from the aquatic invertebrates thriving in the wetlands.

In one study on the effect of the insecticide carbaryl on the growth of ducklings in ponds, the authors found that the growth was reduced by about 40% when compared to a control group (Hunter et al. 1984). Figure 1 illustrates the growth of the ducklings on the control and treated ponds, and for laboratory reared birds. Of 13 insecticides registered for use in the Canadian prairies, carbaryl is one of the least toxic to aquatic invertebrates (Sheehan et al. 1987). An assessment of risk to the aquatic invertebrates based on the modelling of fate and persistence, and short-term laboratory test data, showed carbaryl to be of relatively low risk to the resource (Table 2). We can therefore conclude that many of the insecticides registered for use in Canada may have a much more substantial impact on the wetlands of the prairies and, thus, on duckling growth and survival.

To further address the issue, EC is planning to conduct a study, in cooperation with commercial applicators, to follow the drift of a spray cloud following the

Table 2. Relative hazard ranking of 13 insecticides to aquatic invertebrates based on model of partitioning and persistence and short-term laboratory toxicity test data (from Sheehan et al. 1987).

	Ranking Based on Risk Model		
Ranking Based on Toxicity Test Data	Acidic Pond	Alkaline Pond	
deltamethrin	permethrin	permethrin	HIGH
cypermethrin	azinphos methyl	chlorpyrifos	RISK
fenvalerate	chlorpyrifos	deltamethrin	
permethrin	deltamethrin	methoxychlor	
azinphos methyl	methoxychlor	cypermethrin	
malathion	cypermethrin	azinphos methyl	
methoxychlor	phosmet	fenvalerate	
chlorpyrifos	malathion	diazinon	
carbaryl	fenvalerate	phosmet	
diazinon	carbaryl	malathion	
phosmet	diazinon	carbaryl	
carbofuran*	carbofuran*	dimethoate	LOW
dimethoate	dimethoate	carbofuran*	RISK

* The ranking for carbofuran is tentative as little aquatic toxicity information was available

application by air of a tracer dye to fields adjacent to or containing wetlands. Measurements of deposition on the wetlands will assist in determining the likelihood and extent of contamination under a variety of operational conditions. Presently, a 100 m no-spray zone around wetlands is required when aerially applying synthetic pyrethroids, a class of insecticides extremely toxic to aquatic invertebrates. This study will evaluate the effectiveness of this regulatory requirement in protecting the resource.

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STUDIES ON THE IMPACT OF AGRICULTURAL AND FORESTRY HERBICIDES ON NON-TARGET AQUATIC PLANT COMMUNITIES

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Herbicides (synthetic organic chemicals that specifically kill plants) are an important component of modern agricultural and forestry practices. Herbicides increase crop yield by reducing losses to competing vegetation while reducing labor costs associated with control, thereby making them more cost-effective than other methods of crop protection. A compilation of data from the Manitoba Department of Agriculture (Figure 1) demonstrates that the agricultural use of phenoxy herbicides (principally 2,4-D and MCPA) in the three prairie provinces increased markedly in the 1950s and 1960s, then stabilized in the 1970s and 1980s, by which time approximately half of the arable land in this area was treated. Other "specialty" herbicides, including those for control of Wild Oats (*Avena fatua*), saw increasing use through the 1970s. The net result has been that the quantity and diversity of herbicides used in agriculture has increased significantly in the last two decades. At the same time, uses of herbicides in forestry for site preparation and seedling

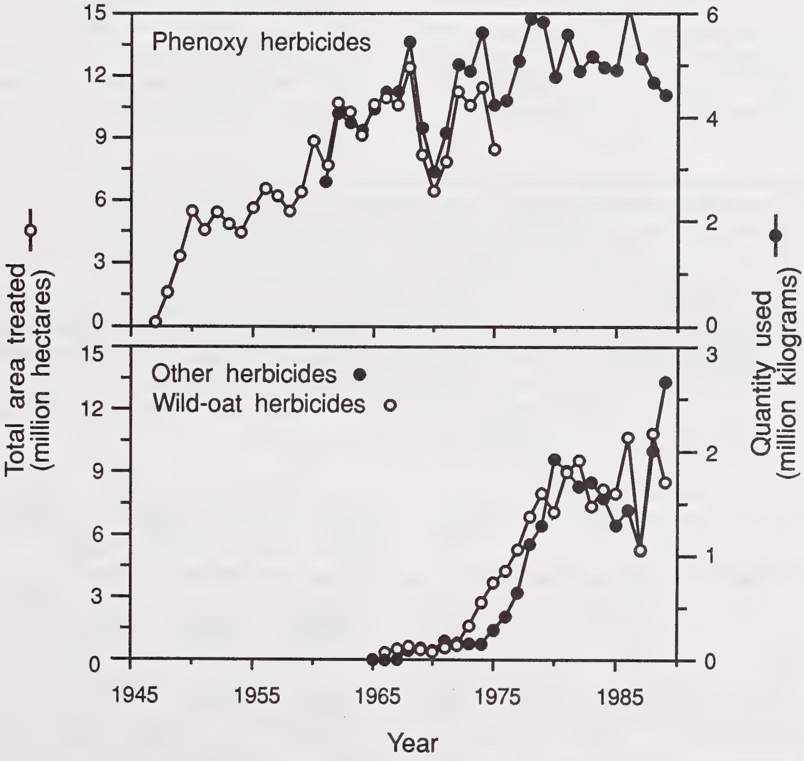

Figure 1. The use (quantity and area treated) of herbicides in Manitoba, Saskatchewan, and Alberta between 1947 and 1989. Categories are those used by the Manitoba Department of Agriculture. Statistics for phenoxy herbicides include 2,4-D and MCPA, "other" herbicides include bromoxynil, dicamba, dichloroprop, linuron, roundup, stampede, tordon, and unspecified others, and wildoat herbicides include asulox, atrazine, avadex, avenge, carbyne, eptam, eradicane, hoegrass, mataven, and treflan. Data were obtained from Anonymous (1947 to 1989).

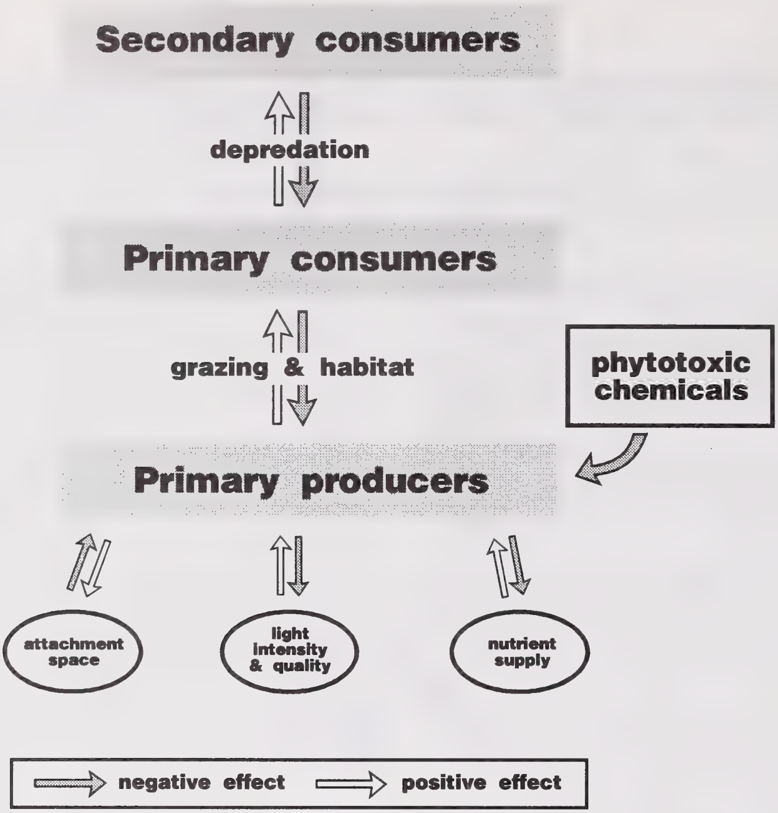

Figure 2. Schematic diagram of some of the natural factors (light, space, and nutrients) and anthropogenic factors (phytotoxic chemicals) influencing primary producers (algae and macrophytes) in aquatic environments. According to the concept of bottom-up control, changes in primary producer biomass or species composition result in altered energy availability to subsequent trophic levels (herbivores and their predators), causing "ripple" effects through the entire ecosystem.

release have increased, although the quantity used is estimated to be less than 1% of that in agriculture.

Given the widespread terrestrial use of herbicides in Canada, the potential is high for off-site movement of herbicide residues in spray drift, adsorbed to wind-borne soil particles, or via runoff water into the aquatic environment. For example, Frank et al. (1990) reported that 84 of 122 rural ponds in Ontario contained detectable residues of at least one herbicide; three ponds contained residues of at least five herbicides. Although Canada is often perceived as having abundant water resources, much of this water is geographically remote or non-potable (e.g., saline). Contamination from herbicide introduction to water reduces the supply of potentially usable water, particularly since the areas of greatest agricultural herbicide use may coincide with areas of fewest surface water supplies (e.g., the southern prairies). One result of this surface water contamination is that algae and macrophytic plants are directly impacted (Figure 2). Due to the bottom-up control of aquatic food webs (McQueen et al. 1989), impacts on these primary producers can affect the availability and quality of food and habitat of aquatic invertebrates, vertebrates, and waterfowl. In other words, direct negative effects on aquatic plants will result in indirect negative effects throughout the aquatic ecosystem. Therefore, it is important to examine the impact of herbicides in the aquatic environment on non-target plant communities. This has been the subject of my research for the past ten years, some results of which I will describe briefly below.

SHORT-TERM EC50 DETERMINATIONS

To investigate the short-term effect of herbicides on algae, I determined the static EC50 (effective herbicide concentration causing a 50% reduction in photosynthetic rate) to natural periphyton (attached algae) communities. Acrylic rods were positioned in the Delta Marsh, Manitoba (50°11′N 98°23′W) and in boreal ponds north of Pine Falls, Manitoba (50°44′N 96°9′W) as surfaces for periphyton colonization. After two to four weeks, colonized substratum segments (2.5 cm long) were collected and placed into filtered water from the site of collection (containing no herbicide residues). They were transported to the laboratory, where a known concentration of an aqueous herbicide solution was added, along with a standard quantity of radiolabelled sodium bicarbonate as a carbon tracer for the determination of carbon dioxide uptake rates. Three replicate determinations were made for each herbicide concentration. The periphyton samples were incubated at a constant temperature under a standard light source for three to four hours. Then the algae were retrieved via filtration and placed into scintillation vials for determination of radioactivity. The resulting data, along with measurements of total available carbon in the water samples, were used to calculate algal photosynthetic rate per unit of substratum surface area (%gC/cm/h). Rates for samples treated with herbicide are expressed relative to those of untreated control samples. EC50 values (mg/L) were calculated by standard probit analysis (Statistical Analysis System 1986). Lower EC50 values indicate greater phytotoxicity.

The photosynthetic response of natural periphyton samples to herbicides is a convenient bioassay for the more general impact of herbicides on non-target plants since periphyton is readily sampled, easily manipulated in the laboratory, and may provide data on the response of a natural plant assemblage that is more ecologically meaningful than those from unispecific laboratory bioassays typically used in toxicity evaluations. A typical dose-response function (Figure 3) shows the relationship of periphyton photosynthesis to the concentration of hexazinone (the active ingredient in the Velpar® commercial formulation used in forestry) in the incubation medium. At low hexazinone

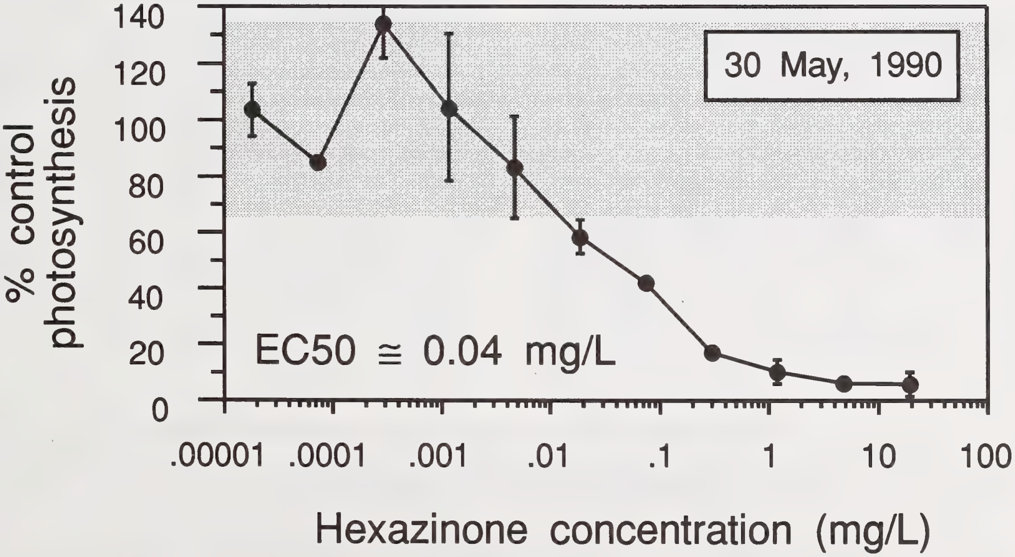

Figure 3. A typical dose-response relationship between herbicide concentration and periphytic algal rate of photosynthesis (% of untreated controls). These data show the response of periphyton collected from the Delta Marsh on May 30, 1990 to hexazinone, a triazine herbicide that is a potent inhibitor of photosystem II of photosynthesis. Each data point is the mean of three replicate determinations and the vertical bars are the standard deviations of those replicates. The horizontal shaded area is the standard deviation of untreated control samples; values within this area are not significantly different from the control. The calculated EC50 is 0.04 mg/L hexazinone.

concentrations, no inhibitory effect on photosynthesis was observed, although in some cases, photosynthetic activity was apparently stimulated over that observed in controls. The reasons for this stimulus may relate to secondary effects of the herbicide on plant metabolism. Within some range, increasing herbicide concentration decreased photosynthesis, until some asymptotic value was reached, above which no further decline was seen. For some herbicides, measurable photosynthesis (taking dark uptake of radiotracer into account) occurred even at the highest herbicide concentration tested, suggesting that some degree of physiological resistance to herbicides exists in natural periphyton communities. Since the periphyton samples are generally composed of several algal taxa, however, the species exhibiting herbicide tolerance cannot be identified and likely varies with the herbicide being tested. Replicate determinations usually exhibited more variability than is expected in unispecific laboratory bioassays, due to variation in algal biomass resulting from spatial differences in algal colonization, accrual, faunal grazing, and algal detachment. In cases of high replicate variability, estimation of EC50 was difficult.

Repeated measurements of EC50 for a given herbicide for periphyton samples from different sample sites and different times of year produced a range of values, likely due to the differences in the respective tolerances to herbicide of the component species making up the assemblage at the time of sampling, and the temporal succession that can occur in the course of a few weeks in natural periphyton communities. Of the herbicides for which sufficient EC50 determinations have been made to allow a comparison, there was considerable variation in the degree of phytotoxicity (Table 1). Hexazinone was the most toxic of the herbicides tested, with EC50 values generally around 0.2 mg/L. Simazine, a related triazine herbicide that is used agriculturally and may be used for control of filamentous algae and macrophytes in farm dugouts (Princep® or Simadex®), was less toxic with EC50s between 0.51 and 0.86 mg/L. Sethoxydim (the active ingredient in Poast®, which is used widely for weed control in broadleaf crops) was less toxic (Table 1). The least toxic herbicides of those tested were difenzoquat (found in Avenge® used for Wild Oat control in cereal crops) and glyphosate (the active ingredient in Roundup® used agriculturally for broad spectrum weed control, Vision® used silviculturally for "conifer release," and in several home-and-garden products), with EC50 values in the range of 35 to 70 mg/L.

A concern on the use of these data is that effects of the herbicides may not be manifested during a three or four hour exposure during the bioassay particularly if the herbicide primarily targets some aspect of plant metabolism other than photosynthesis. Thus the EC50s may underestimate the potential impact on plants exposed to environmentally realistic concentrations. Despite this, however, it is clear that some of the herbicides tested could lead to short-term negative effects on natural non-target periphyton communities in streams and ponds receiving herbicide residues from terrestrial sources. For example, studies on hexazinone residues in streamflow draining treated terrestrial sites have shown that although levels are usually low (e.g., Lavy et al. 1989 report values in the range of 0.001 to 0.003 mg/L, with the maximum after a storm of 0.016 mg/L), transient peaks as high as 0.442 mg/L (Neary et al. 1983) and 0.085 mg/L (Williamson 1988) have been reported, in the latter case from a site in eastern Manitoba. Given some EC50 values for hexazinone as low as 0.04 mg/L (Table 1), short-term impact on periphyton communities in receiving waters could be anticipated.

Table 1. Concentration (mg/L) of selected agricultural and forestry herbicides causing a 50% reduction in short-term (three to four hours) photosynthetic rate of periphytic algal communities (EC50). Ranges of several EC50 determinations for each herbicide are shown.

Herbicide	Active ingredient	EC50 (mg/L)
Velpar	hexazinone	0.04-0.38
Pricep/Simadex	simazine	0.51-0.86
Poast	sethozydim	2.5-8.6
Avenge	difenzoquat	38-67
Roundup	glyphosate	35-70

ENCLOSURE EXPERIMENTS

To investigate the effects of herbicides on periphytic algal communities over a longer time period than used in EC50 experiments, I used a series of in situ enclosures positioned in the Delta Marsh, Manitoba (50°11′N 98°23′W). Initial experiments used cylindrical PVC enclosures 78 cm in diameter and 90 cm high, enclosing a volume of about 300L (Goldsborough and Robinson 1986, 1988). A known concentration of herbicide was added to some enclosures while leaving others as untreated controls. Periphyton biomass (expressed as the quantity of the primary photosynthetic pigment, chlorophyll a) and productivity (rate of photosynthesis measured as above) on acrylic rods positioned in each enclosure were monitored at weekly intervals over a period of six to ten weeks. Water samples were also collected to assess changes in water quality (dissolved oxygen and nutrients) and the quantity of herbicide residues. The effects of herbicide treatment were determined by comparing enclosed water chemistry and periphyton growth in controls with that in treated enclosures.

A shortcoming of this design is that light reduction and restriction of water flow by enclosure walls results in a unique set of chemical and physical conditions within the enclosure ("enclosure effects"), causing different degrees of algal colonization of acrylic rods in a fixed time, with different community composition. Thus, the utility of such small enclosures in toxicological investigations appears to be limited to comparisons of growth in treated enclosures to that in untreated controls. Extrapolation to natural periphyton (and other non-target plant communities) is limited to general trends rather than to specific results. An additional problem is that the study site in the Delta Marsh is prone to rapid fluctuations in water depth due to wind-induced setup of Lake Manitoba to which the marsh is connected. These fluctuations can result in enclosure flooding and loss of herbicide.

To overcome these problems, later experiments used larger enclosures (150 cm diameter by 90 cm high; volume about 1200L) that telescoped with increasing water level to prevent water exchange with the surrounding marsh (Goldsborough et al. 1986). Most recently, I have used 5 m by 5 m square enclosures containing about 21,000L to avoid enclosure effects. The advantage of these over earlier designs is that they are sufficiently large to account for the spatial heterogeneity in macrophyte distribution in the marsh, so a more realistic assessment of the impact of herbicide treatment on a natural marsh channel including macrophytes is obtained. In earlier enclosure experiments, macrophytes were harvested prior to the study to avoid confounding effects of varying quantities and species of macrophytes enclosed within any given small enclosure.

In studies in 1991 using these large littoral enclosures, I observed that the magnitude of enclosure effects appears to have been reduced from earlier designs. However, the necessity of restricting water flow through enclosure did result in lower turbidity within enclosures than in the surrounding marsh, where wind action causes considerable sediment resuspension (e.g., Kotak and Robinson 1991). Four enclosures were established, permitting two to be treated with 0.2 mg/L hexazinone (a concentration in the middle of the EC50 range defined earlier) with two as untreated controls. Acrylic rods were positioned within all enclosures and outside the enclosures to evaluate the magnitude of enclosure effects within enclosure controls. Water samples from all enclosures were collected twice weekly and analyzed chemically for dissolved nutrients and oxygen, and the concentration of the parent herbicide. I found that since hexazinone is relatively water soluble (33,000 mg/L), it dissipated from the water column of the treated enclosures very slowly. No herbicide was detected in the water of the control enclosures. The herbicide concentration at the end of the experiment (seven weeks after herbicide addition) was not significantly different from the initial concentration.

Interestingly, I observed a bloom of phytoplankton (consisting of an organism yet unidentified) occurring in both treated enclosures seven to 10 days after treatment, suggesting that it was physiologically tolerant of this concentration of hexazinone. The depletion of ammonia from enclosure water (which had increased significantly with treatment due possibly to release from decomposing macrophytes and enhanced sediment efflux) coincided with the bloom, suggesting that the algae was photosynthesizing actively. Periphyton biomass and productivity were reduced from pre-treatment levels (to about 20% of levels in control enclosures) although both parameters increased relative to the controls with time (Figure 4), indicating perhaps that community composition was shifting in favor of herbicide-tolerant biotypes. Submerged macrophytes, primarily Sago Pondweed (*Potamogeton pectinatis*) and Water Milfoil (*Myriophyllum exalbescens*), were abundant in the control enclosures, as in the surrounding marsh, but they were eliminated from treated

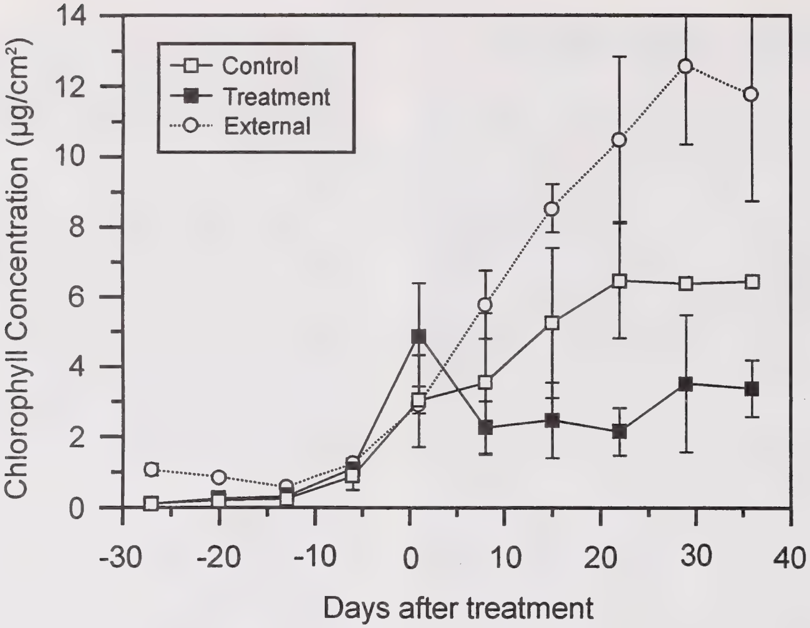

Figure 4. Change in periphyton biomass (μg/cm^2 chlorophyll) over time in enclosures treated with 0.2 mg/L hexazinone at day 0 (solid squares), in untreated enclosures (open squares), and in the surrounding marsh (open circles). Error bars are the standard deviations for two replicate enclosures per treatment.

enclosures within a few days of treatment and did not reappear during the subsequent seven weeks.

WHOLE-POND MANIPULATIONS

The most realistic assessment of the impact of herbicides on non-target plants in receiving waters would involve monitoring the effects of treatment of entire aquatic systems. In 1985, I initiated a study under the Canada/Manitoba Partnership in Forestry Agreement to investigate the potential effects of silvicultural use of the herbicide glyphosate on plants in water bodies that might be oversprayed accidentally during treatment of tree plantations in the southeastern boreal forest of Manitoba. For this study, eight small ponds (0.2 to 0.7 ha surface area, mean depth 0.9 to 1.5 m) in an area subject to glyphosate use (but which had not received herbicide) were selected and fully characterized with respect to water quality (ion and nutrient chemistry), sediment texture and chemistry, periphytic and phytoplanktonic algal biomass (chlorophyll concentration) and productivity (rate of photosynthesis), and macrophyte richness (presence/absence) and abundance (standing crop). Following a 1.5 year period of study, the ponds were assigned to pairs having similar chemical and biological properties.

In late 1986, one member of three of the pairs were intentionally oversprayed with an operational concentration of glyphosate (2.5 kg/ha). Monitoring of water quality (including glyphosate and metabolite residues) and plant production continued, with the objective of determining if any measured parameter deviated out of the normal range of variation observed in the preceding characterization period, as compared to the other member of the pond pair. In 1987, two of the treated ponds from the preceding year (and one additional pond untreated in 1986) were retreated with 6.0 kg/ha glyphosate (the high end of the recommended dosage for forestry). Consequently, of eight ponds, two were treated twice (representing a worst-case contamination scenario), one was treated once in 1986, one was treated once in 1987, and four were untreated controls. Monitoring was discontinued in 1989, but has recommenced in the spring of 1991 to evaluate longer-term effects of herbicide application on the plant communities of treated ponds.

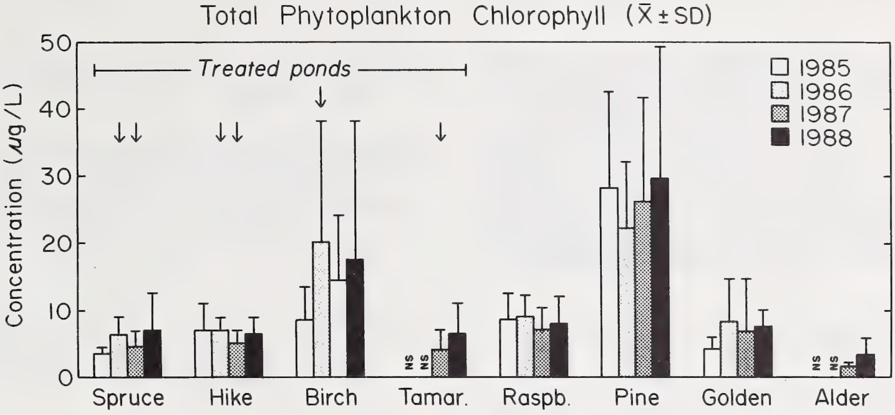

Figure 5. Seasonal mean phytoplankton biomass (µg/cm^2 chlorophyll) in eight study ponds in the southeastern boreal forest of Manitoba (1985 to 1988). The four ponds to the left were treated with operational concentrations of glyphosate (2.5 kg/ha in 1986, 6.0 kg/ha in 1987), while the four ponds to the right were untreated. Vertical arrows indicate the years of treatment. Error bars are the standard deviation of determinations made throughout the ice-free period in each pond. NS = no samples.

Until data analyses are completed in 1993, it will not be possible to evaluate the long-term impact of herbicide contamination on primary production of treated ponds. Glyphosate dissipated rapidly from the water of treated ponds, with first-order dissipation half-lives of less than 14 days (Goldsborough and Beck 1989; Goldsborough and Brown, in press); the maximum glyphosate concentration observed immediately after application was 0.12 mg/L. Comparing this to the static EC50 values for glyphosate (Table 1), it would appear that effects on algal productivity are unlikely, despite the earlier caveat on the extrapolation of EC50 values to prediction of longer-term effects. Water chemistry varied widely between ponds and within a given pond over time; however, from preliminary analyses, it does not appear that water chemistry was altered due to herbicide treatment. Comparisons of annual mean phytoplankton biomass (Figure 5) and periphyton biomass (Figure 6) demonstrate the high variability between ponds; differences between years in any given pond were minor. We did observe that periphyton biomass increased slightly in treated ponds in

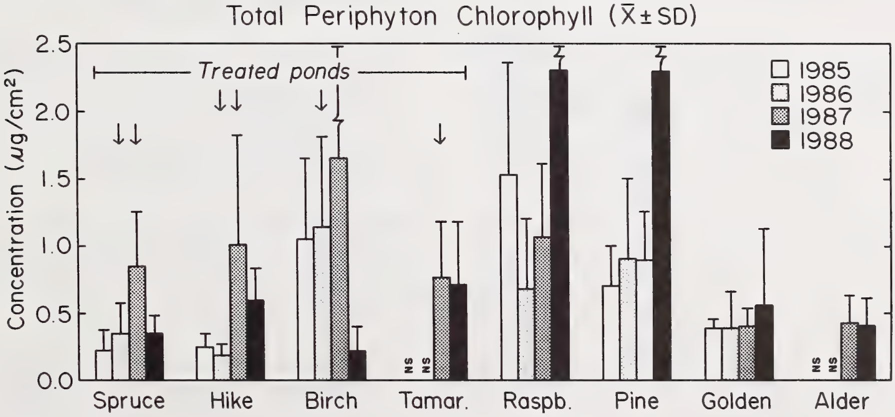

Figure 6. Seasonal mean periphyton biomass (µg/cm^2 chlorophyll) in eight study ponds in the southeastern boreal forest of Manitoba (1985 to 1988). The four ponds to the left were treated with operational concentrations of glyphosate (2.5 kg/ha in 1986, 6.0 kg/ha in 1987), while the four ponds to the right were untreated. Vertical arrows indicate the years of treatment. Error bars are the standard deviation of determinations made throughout the ice-free period in each pond. NS = no samples.

the spring following the first herbicide application, which might be a response to increased nutrient availability (as proposed by Holtby and Baillie 1989) due possibly to delayed development of littoral emergent macrophyte populations in those ponds. By mid-season, no qualitative difference in macrophyte distribution or composition in treated ponds could be observed, and no difference in flowering phenology was seen.

CONCLUSION

It is clear that herbicides may enter natural fresh waters in western Canada. There is evidence, from short-term bioassays and from in situ manipulative experiments, that these herbicides may affect either the biomass or composition of non-target plants at residue concentrations that may occur in receiving waters. Unfortunately, the importance of aquatic primary producers to the functioning of aquatic food webs is often not fully appreciated, so that considerations of "endangered species" may not consider indirect factors such as habitat or food availability and quality, which may be equally important to direct toxicity in determining the survival of an endangered population. Research attention should focus on those organisms that are primarily targeted by environmental contaminants (such as plants in the case of herbicides) in programs concerned with preservation of ecosystems and their constituent organisms.

ACKNOWLEDGMENTS

This research has been supported by an Operating Grant from the Natural Sciences and Engineering Research Council of Canada, the Environment Canada Pestfund, the Canada/Manitoba Partnership in Forestry Agreement, and the Brandon University Research Committee. I gratefully acknowledge the assistance and advice of the staff and researchers of the University Field Station (Delta Marsh), Environment Canada, and the Manitoba Department of Environment, most notably D.J. Brown, M. Forster, R. Kent, G.G.C. Robinson, and M. Zbigniewicz. Commercial formulations of the herbicides used in this study were kindly provided by their respective manufacturers. This is publication number 227 from the University of Manitoba Field Station (Delta Marsh).

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THE PRAIRIE PESTICIDE MONITORING PROGRAM

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The Prairie Pesticide Monitoring Program monitors reproductive success and mortality in birds throughout the agricultural portions of the prairie provinces with the objective of identifying hazards posed by agricultural chemicals to songbirds. The program depends on volunteer monitors who collect data from nestboxes along fencelines adjacent to cropland. These "nestbox trails," some of which have been in place for up to 30 years (Houston 1977), are situated in both parkland and prairie ecoregions. Four species occupy the nestboxes: Mountain Bluebird (*Sialia currucoides*), Tree Swallow (*Tachycineta bicolor*), House Wren (*Troglodytes aedon*), and Eastern Bluebird (*Sialia sialis*), with the latter occurring primarily in Manitoba, where the ranges of the two bluebird species overlap. Nestboxes have the advantages of a relatively low rate of predation, protection from many types of external disturbance, and can be erected where desired, provided there is a fence or means of erecting a post. Although nestboxes are limiting with regard to species, those species that do occupy them represent several different feeding behaviours and hence a variety of potential dietary exposures to granular insecticides, treated seed, sprayed fungicides, insecticides, and herbicides. The timing for treatment of the more common crop pests overlaps the nesting stages of these species to a considerable extent (Figure 1). Monitoring the effects of pesticides on songbirds in agricultural cropland is a high priority of the Canadian Wildlife Service (CWS) and of the Avian Effects Dialogue Group in the United States (Anonymous 1991).

Many "bluebirders" feel that pesticides are causing deaths in nestbox species. During the grasshopper

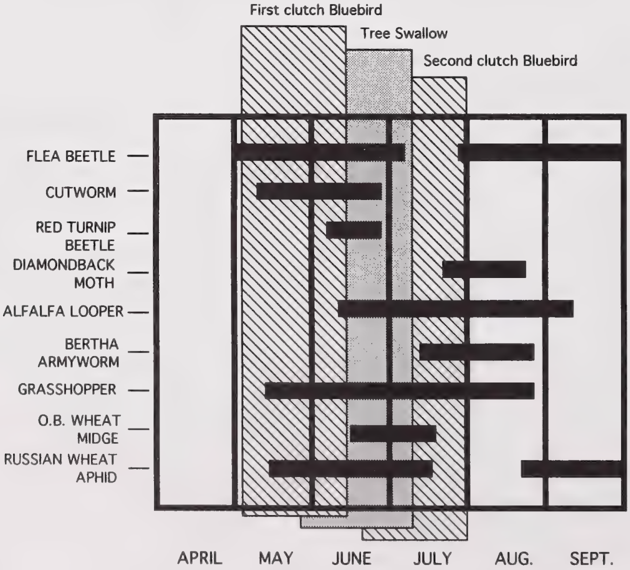

Figure 1. Timing of insecticide use in the prairie provinces in relation to nesting of Mountain Bluebirds and Tree Swallows. All bars indicate spraying with the exception of in-furrow granular or seed treatment for flea beetle (subfamily *Alticinae*) in May and June. (Data adapted from Sheehan et al. 1987, Alberta Agriculture 1985, and additional information from Saskatchewan Agriculture, pers. comm.)

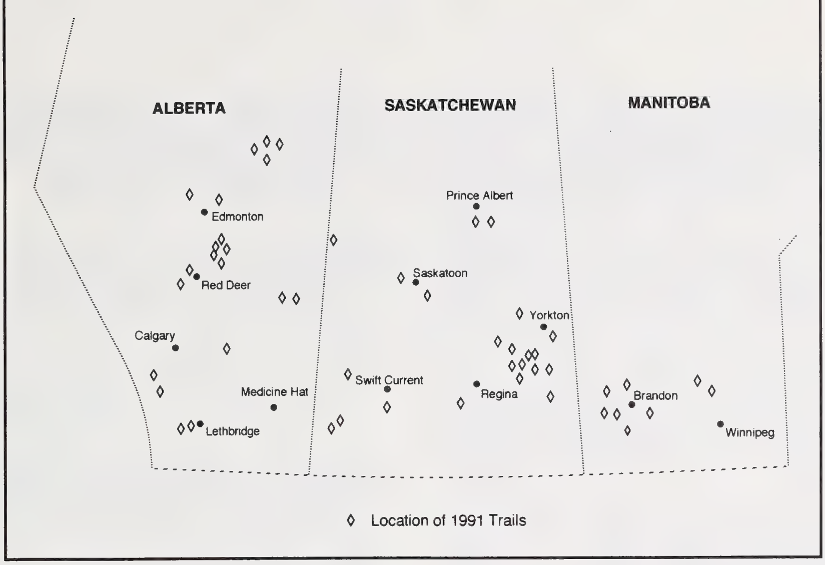

Figure 2. Participating nestbox trails in 1991.

outbreak in the mid 1980s, the authors received several reports from southern Alberta of unusual numbers of nestling mortalities in nestboxes. Observations in the informal literature deal primarily with the effects of carbaryl (Sevin®) use. In the most scientific of these reports, Sevin sprayed for Gypsy Moth (*Porthètria díspar*) at 0.45 lbs/ac (measured deposit) was followed by the death of five Tree Swallow nestlings in a nestbox 16 days after exposure (Bednarek and Davidson 1967). Examination of the data shows that the nestlings that died had hatched prior to exposure, whereas all other nests (n = 11) were exposed in the egg stage. The data also show that predation of two broods took place at the same time as these deaths and was the only predation that occurred. In addition, Wilde (1979) reported abandonment of nests, some of which contained eggs or young, by Tree and Cliff Swallows (*Petrochelidon pyrrhonata*) following dimethoate (Cygon®) application to the base of trees. Also, Eastern Bluebird nestling deaths have been reported following Sevin® application to gardens in which the adults had been foraging (Wilson 1989, Krueger 1988).

Participating trail operators record data from their nestboxes on a weekly basis. Parameters recorded include: number of eggs, nestlings, stage of nestling development (based on appearance), evidence of predation, presence of adults, and mortalities. The number of boxes to be monitored is left up to each volunteer and ranges from 5 to 60. Participants include farmers, business and professional persons, students, and retired persons. Some have placed additional nestboxes next to crops on behalf of the program and many have increased the frequency of their nestbox visits. New participating trails are evaluated by the program coordinators (Pecan Resources Inc.) with regard to habitat characteristics such as land use, type of crops, proximity of wooded areas and waterbodies, class of road, and presence of powerlines.

The program coordinators also obtain information on the pesticides applied near each nestbox from landowners, municipal authorities, and utility companies. This information and the nest records received are used to determine the stage during which exposure to pesticides occurred at each nest (pre-incubation, incubation, or nestling stage). The data are then examined for possible effects of these and other factors on clutch size, nest abandonment, nestling and adult mortality, and overall hatching and fledging success.

In 1990, the first full-scale year of operation, 39 trail operators participated. The first year's data were from relatively pesticide-free areas and were thus used to examine the influence of environmental factors on reproductive success, for example: 1) are nests beside pasture more successful than those beside crops?; 2) what weather conditions affect nestling survival in each species?; 3) are nests in parkland more productive than those in prairie habitat?; and 4) are Tree Swallow nests by water more productive than those away from water?

In 1991, the program expanded into Manitoba. Fifty trails participated (Figure 2) and sent in a total of 720 nest records. Grasshopper outbreaks occurred near some of the Saskatchewan and Manitoba trails, and monitors reported unusually poor productivity in second clutches of Mountain Bluebirds in these areas. In examining the data, we found that nest abandonment by bluebirds was associated with the use of certain insecticides. It is possible that a prolonged rainy period exerted an influence, perhaps in concert with a scarcity of insects following insecticide application.

Several years' data are required in order to discern trends, as many factors are involved. It is hoped that more trails will participate as the program continues. Anyone interested in participating is encouraged to contact the authors.

ACKNOWLEDGMENTS

The authors wish to acknowledge the generous contribution of time and travel from many dedicated trail operators, without whom this program could not succeed. The program has been funded by the CWS, the Pestfund of Environment Canada, and the World Wildlife Fund Toxicology Program.

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ASSESSMENT OF THE GEOGRAPHIC RISK ASSOCIATED WITH INSECTICIDE USE AND BREEDING WATERFOWL IN THE PRAIRIE-PARKLAND ECOREGION OF ALBERTA

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INTRODUCTION

The quantity and quality of breeding waterfowl habitat on the Canadian prairie has declined significantly since the 1970s, largely due to agricultural expansion and intensification. Coupled with this has been an increasing use of pesticides, notably organophosphates, carbamates, and more recently synthetic pyrethroids. These pesticides have the potential to directly affect waterfowl and the quality of remaining habitat. Waterfowl are susceptible to pesticide use through toxicological impacts and ecological effects mediated through their nesting behaviour and food supply (Mineau et al. 1987).

Grasshopper programs have significant potential for direct impact because of the considerable geographic overlap between areas sprayed to control grasshoppers and waterfowl nesting and brood rearing habitat. In the prairie and parkland ecoregions of Alberta, four insecticides accounted for the bulk of grasshopper spraying during the period 1985 to 1989: Furadan, Decis, Lorsban, and Sevin XLR. In 1985 and 1986, two peak grasshopper infestation years in Alberta, approximately 750,000 ha were sprayed with insecticide as control. More than 50% of the area was treated with Furadan and greater than 20% treated with Decis (D. Johnson and M. Dolinski, pers. comm.).

Work by the Wildlife Toxicology and Surveys Branch of Canadian Wildlife Service (CWS) has examined the probable impacts of pesticides on waterfowl by estimating the spatial overlap between nesting ducks and a number of primary prairie crops (Grue et al. 1986). This work recommended the further development and integration of existing databases to improve estimates of the role of pesticides in contributing to waterfowl loss due to agriculture.

This paper describes the use of Geographic Information Systems (GIS) procedures and associated computer models for comparing the distribution and abundance of breeding waterfowl, waterfowl habitat conditions, and insecticide spraying as a means of assessing habitat risk to waterfowl from insecticide spraying.

Project work was divided into two phases. Phase 1 involved database acquisition, development, and GIS mapping of waterfowl and insecticide utilization, and Phase 2 involved identification of the geographic overlap among the mapped distributions to identify related factors.

STUDY AREA

The study area includes the grassland and aspen parkland ecoregions of Alberta, an area of approximately 16 million ha bounded by the 49th parallel in the south, 54 degrees latitude in the north, the Alberta-Saskatchewan border in the east, and 114 degrees in the west. This region is made up of aspen parkland, dry mixed grass prairie, mixed grass prairie, fescue grass prairie (7.3%), and elements of low boreal mixedwood and montane ecoregions (Strong 1991).

METHODS

Waterfowl and Habitat Database Development

Waterfowl survey and pond count data, collected annually by the United States Fish and Wildlife Service and CWS, were obtained from CWS in Saskatoon and Winnipeg. Segment level data were provided for Strata 26-29, for the years 1975 and 1982, two wet years, and 1985 to 1989 a period of drought.

Annual waterfowl and brood survey data are collected using a double sampling plan with stratification. The continent is broken into sample blocks or strata, each block is stratified by transect and transects broken into segment units. Segment units represent a sample strip of rectangular shape (29.97 km x 0.40 km) 11.6 km^2 in size.

Dabbling and diving ducks data were provided as total ducks, not pairs, for all species and for each survey segment. These estimates had been corrected for visibility bias using ground survey data. Brood data represented the number of broods counted for each survey segment, for all species and age classes combined. May and July ponds were provided as total ponds per survey segment.

These data were reviewed and organized and INTERA-TYDAC's SPANS (Spatial Analysis System) GIS used to produce contour maps of densities of dabbling ducks, diving ducks, broods, and May and July ponds. SPANS contouring procedure was used to interpolate segment level waterfowl and pond count point data. Modelling equations were written in SPANS to determine the density of dabbling and diving ducks by county, year, and ecoregion, and May and July pond densities by ecoregion and year. Simple pair-wise correlations (Pearson's r) among the waterfowl and habitat variables were calculated to compare populations patterns and seasonal changes.

Insecticide Purchase Database

Insecticide sales data were supplied by Agriculture Canada, Lethbridge Research Station. This database consists of the complete record of sales of 12 insecticides supported by Alberta Agriculture's Grasshopper Insecticide Rebate Program. The database was coded and checked at the Lethbridge Research Station and contains over 10,000 product sales stored by land location, quantity purchased, cost, product, and quantity sprayed.

Insecticide sales data were converted to GIS format and mapped by summing hectares sprayed for a 10 km survey grid. The sum of the hectares sprayed within a radius of 12.6 km (area 500 km^2) from each grid point was calculated and maps of insecticide utilization produced by contouring grid point totals. The intensity of insecticide utilization was converted to a "spray area ratio" to indicate the proportion of land treated with the quantity of insecticide purchased.

An area of 500 km^2 was selected for the summations of hectares sprayed after calculations over a range of radii, 5, 10, ... 50 km indicated that an area of 500 km^2 provided reasonable precision without extensive smoothing of map detail. Summations and grid calculations were conducted using original FORTRAN programs written for each purpose. These were undertaken for the most common insecticide products registered for grasshopper control: Furadan, Decis, Lorsban, Sevin XLR, and Cygon.

Identification of Geographic Overlap and Assessment of Risk

The geographic distribution of insecticide use in 1985 and 1986 was compared with the distribution of waterfowl and habitat variables for the same years. Survey segment estimates of waterfowl and pond densities and spray intensity were calculated and assigned to Voronoi map polygons. Voronoi maps of the results were produced and simple pair-wise correlations (Pearson's r) among the variables calculated using survey segment estimates of population and pond densities and spray intensity.

Voronoi mapping is a form of fixed polygon reporting in which the polygon boundary is placed according to the minimum distance between adjacent point locations. All territory within a polygon is closer to its central point than to any other point. Values associated with each point can then be applied to the corresponding polygon.

RESULTS AND DISCUSSION

Waterfowl and Habitat Variables

Densities of dabbling and diving ducks and broods were greatest in the aspen parkland ecoregion during all years of the study. Dry years were marked by dramatic declines in numbers in the grassland ecoregions and a retreat to suitable remaining habitat in the aspen parkland. May and July pond densities were greatest in the aspen parkland and forested ecoregions.

During the survey period dabbling duck densities declined by 60% from an average of 385 ducks per survey segment to 155. Diving ducks declined by 43% from an average of 72 to 42 diving ducks per survey segment. Brood densities declined by 74% from an average of 3.97 to 1.02 per survey segment. May pond densities declined by 42% from an average of 64 to 37 ponds per survey segment and July ponds by 33% from 18 to 12 ponds.

All pair-wise correlations of waterfowl and habitat variables had high significant positive correlations. Dabbling and diving duck densities were greatest where pond densities were greatest. Dabbling duck densities were strongly correlated with numbers of May ponds and diving duck densities with July ponds. Brood densities were also positively correlated with May ponds and to a lesser extent with July pond densities. Yearly number of July ponds were strongly correlated with numbers of May ponds. This data suggests that breeding waterfowl use spring wetland conditions as proximate clues for assessing summer wetland conditions.

Insecticide Spraying

Mapped results reveal that spray intensity (i.e., total ha sprayed divided by the area of the summation circle, 50,000 ha) was greatest for all insecticides in grassland ecoregions (1 to 5%). Spray intensity was typically less in the aspen parkland ecoregion (less than 1%). In general, the geographic pattern of purchase and application of insecticide corresponded to the distribution and abundance of grasshoppers. This relationship is not the subject of the present study, but indicates that predictive models of grasshopper population density and control requirements would be useful for anticipating and averting environmental impact, for example, by stocking and distributing alternative insecticide products.

Geographic Overlap and Assessment of Risk

Insecticide utilization tended to be negatively correlated or uncorrelated with waterfowl population density and the presence of ponds. Of the five insecticides surveyed only Decis had a small, but significant ($p < .01$) negative correlation with dabbling duck density. There were no other noteworthy significant correlations for dabbling and diving duck densities or brood densities.

The most significant correlations were those of pond density in May ($p < .01$). Regions with the greatest number of ponds in May tended to have lower insecticide utilization. These may be areas without high-value crops or without weather that leads to significant grasshopper control requirements, as indicated by lower number of grasshopper insecticide purchase.

Voronoi maps of survey segment waterfowl and insecticide variables show a tendency for the highest duck densities and the bulk of spraying to occur in separated regions. Waterfowl and pond densities were greatest in the aspen parkland ecoregion, whereas spray intensity was greatest in the grassland ecoregions. Some geographic overlap occurred in southern Alberta counties notably Warner, Willow Creek, Wheatland, Newell, and Vulcan.

The application of GIS technology is particularly well suited to identifying those locations where risk occurred and for characterizing the separation, although it cannot determine whether this separation is a result of differing weather patterns or of the impact of agricultural practices on wetlands. It is also important to note that geographic patterns and relationships may shift, and should be monitored and even anticipated if possible.

RECOMMENDATIONS

Recommendations for improving databases methodology include: 1) the GIS database developed for this study should be expanded through cooperation with other agencies involved in waterfowl population and habitat management to include Saskatchewan and Manitoba; 2) the insecticide database for Alberta could be improved with the incorporation of data from Wheat Pool counties and chemical corporations; attempts should be made to develop similar databases for Saskatchewan and Manitoba; 3) the GIS database should be applied to an economic study of the options potentially available to limiting the exposure of wildlife to insecticides, with the dual goals of protecting threatened wildlife and encouraging sustainable agriculture; and 4) the methods developed should be reviewed, finalized, and potentially adopted as a standard for comparisons of this type.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Mike Dolinski and Pierre Mineau for their assistance and cooperation. Funding was generously provided for this study by Environment Canada, the Wildlife Toxicology and Surveys Branch, and Agriculture Canada, Lethbridge Research Station.

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WILDLIFE-AGRICULTURE-INTEGRATED PRAIRIE FARM REHABILITATION ADMINISTRATION ACTIVITIES

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BACKGROUND

Both Canada's Green Plan (1990) and the 1990 Report of the Federal-Provincial Agriculture Committee on Environmental Sustainability (Agriculture Canada 1990) focus on eight sustainability issues that are considered most closely linked with natural resources and environmental quality. These eight main issues are: agricultural soil resources, surface and groundwater quality, water quantity, wildlife habitat, air and climate, energy, pollution and waste management, and genetic resources.

The committee's vision for the issue of wildlife habitat is that "Canada's agri-food sector and wildlife resources (are) to be managed for sustainability and long-term mutual benefits."

The Prairie Farm Rehabilitation Administration (PFRA) has a vested interest in wildlife and wildlife habitat because:

1. PFRA manages a large Crown land base (2.2 million acres) containing significant wildlife habitat resources.

2. PFRA promotes "sustainable use" of land and water resources; resources which wildlife relies on for habitat and agriculture relies on for food production.

3. PFRA promotes the concept that wildlife and agriculture can coexist with mutual benefits for both.

4. PFRA recognizes that farmers or other "habitat owners" may need compensation for their efforts to accommodate wildlife and wildlife habitat.

The objective of this paper is to describe a selection of PFRA's present activities which are mutually beneficial to agriculture and wildlife.

1. Canada-Saskatchewan Agreement on Environmental Sustainability

In 1990 Agriculture Canada introduced the Special Income Assistance Program which is an umbrella program providing producers up to $500 million in federal financial assistance. Under this program about $13 million in federal funds was allocated in 1991 to the Environmental Sustainability Initiatives (ESI) program across Canada.

Federal funding of projects includes $2.29 million in Saskatchewan, $1.77 million in Alberta and $0.6 million in Manitoba. These monies were matched by the provinces.

The Canada-Saskatchewan ESI agreement entails 55 federal projects and 24 provincial projects. Six federal projects relate directly to wildlife and wildlife habitat and 5 are outlined below (see Bristol, this volume for 6th).

1.1 Burrowing Owl (*Athene cunicularia*) Program - $1,350

This project aids an extension effort by the Saskatchewan Natural History Society to send out a newsletter to all Operation Burrowing Owl participating landowners informing them of general interest articles and requesting information on the annual count of Burrowing Owls. Another newsletter will be mailed out in 1992.

1.2 Carbofuran Use in Burrowing Owl Habitat - $8,100

This project's objectives were to heighten awareness of pesticide (Furadan) restrictions among landowners having Burrowing Owls on their land. The project also hopes to strengthen landowner contact with Operation Burrowing Owl and encourage sign up of new participants. As a result of the project over 50 new landowners signed up.

One hundred Saskatchewan landowners were administered a telephone questionnaire on Furadan use. Of the 100 landowners contacted, 35 had used Carbofuran at some time in the previous five years. Eighty-two percent were familiar with Burrowing Owls and 62% were familiar with the program Operation Burrowing Owl. Although 31% were partially aware of some restriction or of the toxicity associated with Carbofuran, not one person involved in the survey knew the exact restriction associated with the application of Carbofuran with respect to the Burrowing Owl. The results indicate the labelling restriction is ineffective in conveying the message that Furadan use may impact Burrowing Owl populations.

1.3 Pilot Habitat Retention Program - $78,650

The objectives of this project are to determine landowner preferred wildlife habitat retention options utilizing a landscape (Agro-ecological Resource Region) approach in the shortgrass prairie. The project was sponsored by the Saskatchewan Wildlife Federation who selected Western Resource Management Associates Ltd. of Yorkton to deliver the program.

The consultants are presently assembling various data bases (maps, soil survey, Crown land) and plotting existing wildlife habitat (uncultivated land). The project will also entail a mailout questionnaire directed at landowners in a select Saskatchewan rural municipality within this landscape region.

1.4 Management Plan for Douglas Provincial Park and Elbow PFRA Community Pasture - $5,000

Originally proposed by Parks Branch of Saskatchewan Natural Resources (SNR) the objective from SNR's point of view is to assess the current state of Douglas Park's vegetation and recommend future management actions. PFRA is interested in developing a management plan for Elbow Community Pasture which is part of the same landscape. The project has been contracted to Saskatchewan Research Council's Applied Plant Ecology Section. The studies' findings will be used by SNR and PFRA to decide how the rangeland can be managed in an integrated fashion to meet grazing, wildlife, recreation, and preservation needs (see Nykoluk, this volume).

1.5 Soil, Water, and Wildlife Degradation Exhibit - $20,000

This ESI project is one component of three-linked projects which will be integrated to form an agricultural display trailer. The three components include:

1. An Agricultural Resource Region Exhibit (Landscape Approach) - This exhibit is sponsored by the Saskatchewan Research Council and will provide a message that identifies the location and formation of agricultural resources. Resource history, soil and water cartography and technology will be highlighted.

2. A Soil, Water, and Wildlife Resource Display - Ducks Unlimited (DU) Canada is developing this exhibit which will convey the message that integrated agriculture requires improved efficiency and management of water resources. The exhibit will point out that farmers face a number of water management options which govern salinity, erosion, soil fertility, water cycling, crop and livestock production, and wildlife habitat.

3. An Integrated Agriculture Exhibit - The Saskatchewan Wheat Pool will provide this exhibit which focuses on the economic and social realities faced by farm producers over four generations. The key message will be that farmers care for the land and that sharing of resource responsibilities is required.

2. Integrated Range Management in PFRA Pastures

PFRA administers 2.26 million acres of range resources in 87 community pastures. In Saskatchewan at least half of the area in 62 pastures has been rated "critical" wildlife habitat by SNR. In addition, the PFRA pasture system provides space and resources for a variety of non-agricultural activities such as hunting, wildlife and landscape viewing, watershed protection, forest pulp cutting, mineral extraction, preservation of heritage resources, research and recreational parks.

PFRA presently integrates long-term range development and improvement strategies with wildlife concerns by passing its 5-year development plans to the provincial wildlife agency (SNR) for review. If there are serious conflicts, the two agencies seek alternative ways of addressing the needs of wildlife and livestock. Fifty-one pastures now have approved multi-use plans in various stages of implementation.

PFRA is involved in several projects that support the objectives of the North American Waterfowl Management Plan: waterfowl habitat enhancement in PFRA pastures; Permanent Cover Program and Prairie CARE (Conservation of Agriculture, Resources and the

Environment); inventory of waterfowl potential in PFRA pastures; and integrated pasture management in the Mount Hope, Prairie Rose, and Monet PFRA pastures (see Bristol, this volume for details).

2.1 Coalfields PFRA Pasture - Integrated Range Management

As an example, PFRA proposed shrub control in Coalfields PFRA pasture as a method to increase cattle carrying capacity. Since shrubs are an important component of wildlife habitat a conflict arose.

SNR and PFRA jointly developed a "go slow" experimental herbicide application which is being implemented by PFRA. Wildlife staff will attempt to identify what the impact of strip spraying is on Sharp-tailed Grouse (*Tympanuchus phasianellus*) and other wildlife habitat while PFRA will assess the herbicide application from the cattle and range production points of view.

2.2 Grazing Management in Suffield PFRA Pastures - Alberta

The Suffield pasture in Alberta consists of three blocks of rangeland called: 1) Casa Berardi, 2) Koomati, 3) Queenston.

The Suffield situation is unique in that management relies upon mutual agreement by the Suffield Grazing Advisory Committee, the Department of National Defence Canadian Forces Base Suffield, and PFRA.

Current grazing management techniques to improve native grassland condition include: 1) rest-rotation grazing in the Casa Berardi block, 2) a three field deferred rotation in Queenston block, and 3) alternate water source development to relieve excess grazing pressure and erosion potential on the South Saskatchewan River breaks in the Koomati block pasture. Preliminary financial forecasts to fence out the river breaks are complete ($48,000).

Additional well development costs are estimated at $73,000. These grazing management strategies should improve the quality of wildlife habitat available in the Suffield complex.

3. PFRA - DU "Demo" Dugouts

In June 1990, DU and PFRA met to discuss joint projects to demonstrate improved water quality and enhanced waterfowl nesting success in and adjacent to dugouts. As a result, about 15 demonstration projects have been initiated on selected dugouts. Through PFRA's Water Development Section, DU will be supplied with names of clients constructing dugouts. DU will select cooperators from key waterfowl production areas and assist the farmer in preparing dugout plans. DU will promote levelling of spoil piles, seeding of grasses, fencing out dugouts plus buffer areas and pumping water for livestock. Farmer benefits should include improved water quality, lower dugout maintenance costs, and extended use of the dugout. Waterfowl benefits include improved waterfowl nesting opportunity and improved brood survival through improved brood salvage water.

4. Rare and Endangered Wildlife Species

The 1992 list of threatened and endangered wildlife species published by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) lists 230 species of mammals, birds, reptiles, amphibians, fish, and plants at risk. The PFRA pasture system provides some of the best remaining native habitat for many threatened prairie wildlife species.

Since 1984 PFRA has cooperated in the Swift Fox (*Vulpes velox*) release program by providing secure habitat in the Govenlock, Nashlyn, Battle Creek pasture complex in southwest Saskatchewan.

PFRA reviews its pesticide program annually to avoid negative impacts on species such as Burrowing Owls. Research has shown that Burrowing Owl nest burrows sprayed directly with carbofuran produced 83 percent fewer young (Fox et al. 1989).

PFRA is currently cooperating with other government agencies such as SNR and the Canadian Wildlife Service to identify critical habitats for rare and endangered species within the pasture system. PFRA is committed to maintaining the biological diversity of the landscape, especially on PFRA lands and will work with all land users to provide stewardship of endangered wildlife resources.

5. Shelterbelts for Wildlife - Save Our Soils (SOS) Program

Field shelterbelts are an integral part of soil conservation on the prairies because they reduce wind erosion. Shelterbelts also conserve soil moisture because they trap snow and reduce evaporation. Another reason for planting trees is to provide shelter and food sources (habitat) for wildlife.

Farmers and ranchers wishing to plant shelterbelts can request help in shelterbelt planning, design, and maintenance and can order tree and shrub seedlings free from the PFRA Shelterbelt Center at Indian Head.

Through the SOS program of the Canada-Saskatchewan Agreement on Soil Conservation financial assistance is also available for shelterbelt planting and maintenance. PFRA, SNR, and the SOS program jointly encourage landowners to consider wildlife when developing tree plantings in key target areas of southern Saskatchewan. In addition, shelterbelt centre staff travel to Manitoba to assist farmers in planning and design. In 1990, PFRA staff visited 44 landowners within target areas and 63 in other areas of Saskatchewan and Manitoba.

In 1991, PFRA distributed 11.83 million trees to applicants in Saskatchewan, Manitoba, Alberta, and the Northwest Territories. Trees distributed for special wildlife shelterbelts and block habitat plantings totalled 457,395 for Saskatchewan and Manitoba in 1992.

6. Rafferty-Alameda - Mitigation Plantings

The Rafferty-Alameda Water Conservation Project is basically complete. The Initial Environmental Evaluation (IEE) (Environment Canada 1989) presents information on environmental impacts affecting federal interests, identifies possible methods of mitigation, and identifies data gaps. The IEE predicted significant adverse environmental impacts on the Ferruginous Hawk (*Buteo regalis*) and Baird's Sparrow (*Ammodramus bairdii*) (threatened) and potential impacts on seven rare plant species. Provincial agencies also expressed concern over inundation of Sharp-tailed Grouse and White-tailed Deer (*Odocoileus virginianus*) habitat.

To mitigate for lost wildlife habitat, the Souris Basin Development Authority is working to purchase 61 quarter sections of land near the two reservoirs for the use of wildlife. In terms of size and the proportional amount of money to be spent, these mitigation measures are the largest ever undertaken in Canada.

The PFRA Shelterbelt Center at Indian Head was the logical source of plant material needed for the mitigation plantings (conversion of cultivated lands to wildlife habitat). As a result PFRA committed to enhancing cover on 31 quarter sections of land with an objective of converting 25-50% of each quarter to tree and shrub cover. Since 1988, 20 quarter sections have received treatment at Rafferty and 598,565 trees have been planted. Planting trials will also be initiated at Alameda reservoir in 1992 (35,000 trees).

The remainder of the mitigation lands will be seeded to grasses and shrubs on the basis of the habitat requirements of the wildlife species expected to use these lands. Hopefully, a native grass mixture can be seeded on some of these mitigation lands to improve biological diversity in the area.

7. The Future

Prairie people face a major challenge in bringing about a more sustainable or integrated agriculture. Attitudes and thinking must change. The caretakers of the land cannot deliver sustainability on their own. PFRA can play an ongoing and even greater role in integrating wildlife and agriculture on the landscape for enjoyment now and for future generations of Canadians.

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PRAIRIE FARM REHABILITATION ADMINISTRATION, COMMUNITY PASTURE RANGELAND INVENTORY, AND RANGE SITE BENCHMARK ESTABLISHMENT

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The world conservation strategy has identified three global objectives for living resource conservation, and they are to: 1) maintain essential ecological processes and life support systems; 2) preserve biological diversity; and 3) to ensure the sustainable use of species and ecosystems (World Wildlife Fund 1988).

Since these global objectives must be recognized at the national, regional, and local levels, the establishment of the Prairie Farm Rehabilitation Administration (PFRA) community pasture range site benchmark reference areas will contribute in a proactive matter towards this very meaningful world wide initiative. The establishment of these areas is also congruent with the concept of "think globally and act locally." These reference areas will provide a valuable basis for a prairie rangeland ecosystem conservation strategy which was identified in the Prairie Conservation Action Plan.

According to the Flora and Fauna Advisory Group report of March 1991, there are 81 nationally rare vascular plants for Canada occurring in Saskatchewan alone. Hence, an ecological reference area such as the establishment of a range site benchmark for a specific "potential natural plant community," is in our view an important attribute of PFRA ongoing rangeland inventory activities to assess, measure, and monitor the ecological status of our natural grasslands under certain livestock grazing management practices.

The decision to select any range management alternative requires the ability to recognize and predict any possible changes that will result from different management applications under different environmental conditions. Therefore, the PFRA community pasture program recognizes the need for rangeland biophysical inventory information as a basic prerequisite in the conservation, management, and planning of our rangeland resources in western Canada.

A range site benchmark is defined as a permanent reference point, in range inventory, that is used as a point where changes in vegetation through time are made (Kothmann 1974).

The range site (or ecological site benchmark project) is part of our ongoing rangeland inventory work in the evaluation of native range condition, the "apparent" and "measured" trend, (directional changes in secondary succession), and the potential above-ground biomass productivity for a specific plant community association.

Livestock grazing is a biotic process, and it is one of the driving variables which often has a significant impact upon natural plant community development. Hence, the basic range management objective is to identify and quantify these changes from an ecological perspective. We must be capable of modifying our livestock grazing management practices (i.e., seasonal stocking rate adjustments, implementing grazing systems, etc.), based on the current seral stage of natural plant associations.

The selection and establishment criteria for PFRA range site benchmarks have been standardized in Saskatchewan along with other agencies. They are as follows:

1. The site should be one hectare in size, and representative of a particular range site or (habitat type) in "undisturbed" condition.
2. The site should contain the potential natural plant community for that specific site. It must be stable and expected to remain undisturbed over the long-term.
3. The site should be of representative landform, soil type, slope, etc.
4. A two-way exclosure is required to protect the benchmark site from livestock grazing; wildlife use is allowed.
5. The site should be in close proximity to a weather data collection station.

6. The site should be accessible for use in demonstrations and as a teaching tool.

7. The site should be in close proximity to grazed areas.

The data collection of range site benchmarks consists of the following elements:

1. Benchmark name and location description.

2. Physical description of each site including: soil surface texture, parent material, soil profile, and soil chemical analysis.

3. History of the site including: degree of past use/non-use, evidence of fire, and insect activity.

4. Vegetation including: plant species composition, % of ground canopy cover, litter cover, above ground biomass productivity, and frequency of species occurrence.

A data storage and retrieval system has been established. A personal computer database system has been set up, and data entry for transect information will be completed by the range management staff each year. Range site benchmark data are then correlated on the basis of plant species composition, production of the potential plant communities, and soils.

In conclusion, it is our view that native prairie rangeland under livestock grazing can be best managed from an ecological perspective. Range site reference areas can provide us with essential information in the evaluation and monitoring of our rangeland ecological status. It will enhance our ability to manage this very important resource in Western Canada.

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WORKING TOWARDS MULTIPLE USE MANAGEMENT ON PRAIRIE FARM REHABILITATION ADMINISTRATION COMMUNITY PASTURES

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To set the stage for our workshop today, I would like to present a brief overview of: Prairie Farm Rehabilitation Administration's (PFRA) community pasture rangeland resource, PFRA's mandate, and a description of our Environmental Assessment and Review Process.

I would also like to relate to you a few of our experiences in working towards achieving our goal of multiple use management on PFRA community pastures.

Today PFRA community pasture lands total 913,916 hectares (or 2,258,286 acres). This is equivalent to an area of 95.5 km^2. There are 87 community pastures across the three prairie provinces: 62 in Saskatchewan, 24 in Manitoba, and 1 in Alberta. The average pasture size is about 10,000 hectares. Many of these pastures came into operation in the 1930s and 1940s and our mandate ensures that wise use of the resource shall prevail in the long-term. PFRA has a proactive commitment to the protection and management of wildlife habitat on its rangelands. Indeed, this habitat exists today because of the long-term range management program PFRA has administered. A recent inventory of the PFRA rangeland resource has revealed that over 80% of our land base is composed of native vegetation (Cook 1991, pers. comm.).

To gain an appreciation of what PFRA has been up to for the past 54 years or so, a look at our federal mandate is essential. Our mandate consists of 2 broad objectives: conservation and summer grazing for cattle.

OBJECTIVE 1: CONSERVATION

To make possible land use activities that are compatible with the production capabilities of the soil and to facilitate improved land use through rehabilitation, conservation, and management of the rangeland resource.

Principles

It is understood that:

1. Permanent vegetation cover will be established and maintained on pasture lands recognizing the value of native vegetation and the role of trees, shrubs, and domestic forages in providing a diverse plant community within the landscape.

2. The resources will be managed in a holistic fashion to ensure a viable, productive, and sustainable ecosystem.

3. Compatible agricultural and non-agricultural use will be made of the resources.

Goals

1. To facilitate suitable land use.

2. To promote responsible resource management and ensure sustained productivity.

3. To provide stable, long-term management which combines protection, development, improvement, and utilization of the resources.

OBJECTIVE 2: SUMMER GRAZING FOR CATTLE

To utilize the resource primarily for the summer grazing of cattle while assisting in stabilizing small farms and providing breeding bulls to encourage high quality, long-term cattle production.

Principles

It is understood that:

1. These lands should remain productive and are to be used primarily for agricultural purposes.

2. Through the provision of grazing on these lands, agricultural diversification and the opportunity for mixed farming and thus maximization of opportunities on patron land can be facilitated.

3. Proximity to the pasture will be used as an eligibility criteria.

4. Grazing privileges will be allocated in a way that will afford all eligible applicants reasonable utilization of the rangeland resources.

5. Responsible livestock and range management practices will be utilized and promoted.

Goals

1. To use the resource primarily for the summer grazing of livestock.

2. To stabilize economic conditions and diversify farming operations in rural areas.

3. To maintain the rangeland ecosystem, which evolved with ungulate grazers, by the use of domestic livestock.

FEDERAL ENVIRONMENTAL ASSESSMENT REVIEW PROCESS

PFRA has made the following arrangements to ensure proper planning, assessment, and environmental acceptability of community pasture development proposals. In Saskatchewan, PFRA identifies all proposed range developments to the Department of Saskatchewan Natural Resources (SNR), well in advance of construction. Impacts on critical wildlife habitat, fragile prairie ecosystems, and wildlife populations are determined, and plans are modified where necessary. Where significant adverse environmental impacts are identified, the proposal is assessed in more detail, and may be modified, and in some cases, abandoned.

A similar procedure is followed for development planning on community pastures within the Province of Manitoba. Consultation, cooperation, and exchange of information takes place with the Wildlife Branch, Manitoba Environment, Crown lands, and the Forestry Branch.

Within Alberta, PFRA operates one community pasture on the Canadian Forces Base Suffield. A Suffield Grazing Advisory Committee has been established under a Memorandum of Understanding between PFRA and the Department of National Defence. The purpose of the committee is to ensure that the pasture receives proper range use consistent with the conservation of lands subject to grazing. Committee members include representatives from each of Agriculture Canada, Canadian Wildlife Service, Alberta Forestry Lands and Wildlife, and Alberta Agriculture. PFRA is not a member of this committee.

This multi-disciplinary pasture planning process has evolved over several years, based on our range management experience, and the cooperation and valuable advice received from cooperating wildlife agencies. We feel that this process is effective, because the site specific assessments provided by conservation officers, field ecologists, and range management staff provide us with detailed knowledge of the resources intended for development.

MULTIPLE USE MANAGEMENT

The road towards achieving multiple use management on PFRA community pastures has not always been an easy one, and we recognize that there is still a lot of work to do. Nonetheless, working with different agencies is a welcomed challenge.

We recognize the need for "in house" expertise. We must be able to interpret available scientific literature, and be able to communicate with cooperating agencies whose mandates differ from ours. PFRA has acquired a wildlife habitat biologist and a waterfowl biologist. In the last year PFRA has been able to increase its Range Management staff in the Pasture Planning Section. Agencies who work with us must be able to understand PFRA's goals and objectives, and they must believe that the integration of livestock and wildlife interests is possible. An element of trust and understanding must be developed through sincere efforts at communication. Cooperative programs and projects necessitate that more people be involved, and more time be spent in the decision making process. This means that it takes a lot more time to get things done.

There is a need for more information on the habitat requirements of various wildlife species on PFRA community pastures, and wildlife/livestock interactions. There is also a need for more information on habitat management, as opposed to preservation of habitat.

Rangelands are dynamic in nature and they have evolved under extreme influences such as fire, drought, insects, and overgrazing. Historically, aboriginal man used fire as a means of attracting the American Bison (*Bison bison*), so there are also anthropogenic influences. Grasslands co-evolved with both grazers and browsers, and domestic cattle provide an ecological substitute for bison. Preservation alone will remove many of the biotic factors that have shaped rangelands as we know them today. There is already considerable research that suggests that ungrazed rangelands are not as diverse and productive. The loss of grasslands to shrub encroachment that we have seen all over North American rangelands, may be due in part, to man's control of fire.

PFRA operates its pasture program on a "user pay" cost recovery basis, through fees for services such as grazing, breeding, and mineral extraction. If other interest groups wish to initiate environmental projects, then financial and personnel resources will have to be provided for planning, implementing, maintaining, and monitoring cooperative projects. Agricultural users are not the sole benefactors on PFRA community pastures, and therefore, should not be expected to pay for these non-agricultural initiatives. I am pleased to say that PFRA has chosen to be proactive on wildlife matters instead of reactive, and here are just a few of the initiatives that we have undertaken.

PFRA pastures have hosted numerous Ducks Unlimited (DU) water projects through the years, and as you will hear later this afternoon, PFRA and DU staff have been working together to develop planned grazing systems that will benefit waterfowl and range condition. We hope to have two of our pastures operating on such systems during the next grazing season, and we plan to continue these types of projects.

We have been working with the Saskatchewan Research Council and SNR on a vegetation management study for the Elbow Community Pasture, and the adjoining Douglas Provincial Park. We are trying to determine the impact of ungulates, fire, and drought, on a sensitive sand dune complex. In addition, this year we undertook a project utilizing sheep for the biological control of Leafy Spurge (*Euphorbia esula*) at the Elbow Community Pasture.

A multiple use management plan was initiated at the Coalfields Community Pasture. Participating agencies included SNR staff and PFRA shelterbelt and range management staff. This project was most valuable in terms of setting up the multiple use concept for the community pasture program.

We are also developing our extension initiatives—we will be offering increased education on different aspects of range management to both the general public and our own range management field staff.

In closing, I hope that I have been able to give you a picture of how PFRA approaches multiple use management on community pastures, through the mandate of one of Canada's oldest soil conservation programs. We hope that any agencies or groups who would like to work with us will feel welcome to do so. We feel that partnerships will continue to be the most efficient way to ensure that all conservation objectives are met.

WATERFOWL FRIENDLY PLANS AND PROGRAMS IN PRAIRIE FARM REHABILITATION ADMINISTRATION PASTURES

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Recently Prairie Farm Rehabilitation Administration (PFRA) has become involved with a number of wildlife-agriculture integrated activities. The activities that relate directly to waterfowl include the following.

1. PFRA AND THE NORTHERN AMERICAN WATERFOWL MANAGEMENT PLAN (NAWMP)

1.1 Waterfowl Habitat Enhancement in PFRA Pastures

In February 1991, the Saskatchewan Wetland Conservation Corporation (SWCC) invited PFRA to submit a waterfowl habitat proposal for possible NAWMP funding. Under the NAWMP guidelines, Canadian applicants can submit project proposals for funding through the 1989 United States Congress North American Wetlands Conservation Act. United States federal grant monies are matched with other United States and Canadian funds to secure, develop, enhance, or manage wetlands in Canada. In May 1991, PFRA presented a six year $3.24 million proposal to SWCC for implementation under NAWMP starting in 1992 (Weins 1991). The proposal contained the following elements for development:

1. Design and implementation of integrated wildlife friendly range management plans on 21 PFRA pastures within NAWMP program areas.

2. PFRA acquire a NAWMP funded wetland team to develop an inventory of waterfowl habitat and design management plans that are beneficial to waterfowl and range management.

3. PFRA acquire NAWMP funded personnel to manage the integrated range plans.

This proposal has been approved in principle. The funding and delivery of this proposal has been incorporated into the Ducks Unlimited (DU) Delivery System. Also PFRA and DU are developing demonstration dugouts to improve water quality and enhance waterfowl nesting success (see Weins, this volume).

1.2 PFRA - Permanent Cover Program (PCP) and Prairie CARE (Conservation of Agriculture, Resources and the Environment)

A PCP was first offered under the three year National Soil Conservation Program for Alberta and Saskatchewan in 1989. An enhanced program (PCP II) for all three prairie provinces was introduced in 1991 under the Farm Support and Adjustment Measures Program. PCP II is designed to meet the environmental sustainability goals outlined in the Agriculture Policy Review and the Green Plan (Anonymous 1991).

Prairie CARE is the major program component of an overall strategy offered under the NAWMP, and is delivered on behalf of the plan's partners by DU Canada, the SWCC, Alberta Forestry, Lands and Wildlife, and the Manitoba Habitat Heritage Corporation. Prairie CARE is designed to promote a land stewardship or land ethic that will change agricultural management practices so that wildlife can exist in harmony with agriculture.

PFRA is both the delivery agent for PCP programs and a member of the Prairie Habitat Joint Venture Advisory Board which endorses and evaluates NAWMP programs. The PCP programs and Prairie CARE are integrated because putting cover back on the land not only prevents soil and water degradation but also provides enhanced wildlife habitat.

Landowners eligible for PCP II may also qualify for additional money under option 2 of this program. This option targets specific rural municipalities in NAWMP program areas; land is leased for exclusive use by wildlife. Participating landowners will receive grass seed suitable for nesting cover, plus an annual lease payment following stand establishment. By the end of December 1991, 5,900 applicants were committed to the program. Expenditures totalled $30.5 million and covered 485,000 acres.

2. CANADA-SASKATCHEWAN AGREEMENT ON THE ENVIRONMENTAL SUSTAINABILITY INITIATIVE (ESI)

This $13 million agreement was signed in 1991. Its aim is to assist the agri-food industry achieve environmental sustainability. The agreement covers a range of projects that support effective resource management and environmentally sustainable agricultural practices.

The Canada-Saskatchewan ESI agreement includes fifty-five projects. Six of these projects relate directly to wildlife and wildlife habitat.

One of the six projects is to conduct an inventory of waterfowl habitat in PFRA pastures. To complete this project, PFRA has retained the services of a waterfowl biologist for a 1-year term. The objectives are: 1) to initiate an assessment of existing wetland habitat and waterfowl use on six of twenty-one PFRA pastures that are within NAWMP program areas; 2) to priorize the pastures for waterfowl habitat management; 3) to design planned grazing systems for those pastures having potential for waterfowl production; 4) to assist PFRA and DU with implementation of planned grazing systems; and 5) to assist PFRA and DU in planning and developing 1992 NAWMP funding proposals and to recommend where the NAWMP evaluation program could be incorporated to monitor waterfowl production with respect to planned grazing systems.

3. INTEGRATED PASTURE MANAGEMENT - MOUNT HOPE-PRAIRIE ROSE PASTURE

In 1987 PFRA and other NAWMP partners developed a study proposal to enhance waterfowl habitat and sustain forage production for the Mount Hope-Prairie Rose Pasture in east-central Saskatchewan. In January 1991, PFRA and DU signed an agreement for a cost-shared project to implement a rotational grazing system. The objectives include improved waterfowl nesting success due to improved residual cover and reduced disturbance during waterfowl nest initiation. As well it will improve the current pasture condition by distributing the cattle more evenly over the entire pasture, reducing selective grazing by livestock and allowing periods of rest during the active growing season.

The development plan involves subdividing the current ten field pasture into 21 grazing cells. This required the construction of 22 miles of solar powered and suspension fencing. Additional water developments were also required to complete the system. Nine new well sites were developed to ensure that stockwater supplies would be adequate during drought conditions.

The management plan, which will be implemented in 1992, has five rotational grazing units. Each contains four fields that will be grazed in rotation and one field that will be continuously grazed (this will act as a control). The cattle will graze in the first field until early July and then be moved through the remaining three cells for the balance of the grazing season.

4. INTEGRATED PASTURE MANAGEMENT - MONET PFRA PASTURE

Monet is the highest ranked PFRA pasture of the six sites investigated as part of the waterfowl inventory conducted in 1992. It is located in west central Saskatchewan in the northern part of the Missouri Coteau. The development plan is scheduled to be implemented in 1992/1993. Improvements include 24 miles of suspension fence and development of eight new water sites. Range management includes a change from continuous grazing to a deferred rotation grazing system. Benefits include improved upland nesting habitat (due to improved residual cover), reduced disturbance during nest initiation, improved livestock distribution with less selective grazing, and overall improved range condition.

The pasture will be divided into five grazing units, depending on breed of cattle or breeding condition. Each unit will have from four to seven smaller fields that will be grazed once per year. Two fields currently in tame Crested Wheat Grass (*Agropyron cristatum*) will be fenced separately from the native pasture and will be utilized for early season grazing. This serves to defer grazing of native range in two of the units and concentrates the grazing pressure in poor quality waterfowl habitat. The cattle are then moved into each of the native fields in rotation. Grazing period is dependant on field size, number of fields in the unit, and forage availability. This system ensures that at least three fields in each unit will remain undisturbed until after peak nest initiation by waterfowl occurs in the latter part of June.

In summary, I will say that the focus of this individual presentation has been directed specifically at improvements for waterfowl. However, if we consider integrated resource management for agriculture and wildlife, many wildlife species found within the pastures will benefit from projects such as these.

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RESTORING NATIVE PRAIRIE ECOSYSTEMS

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INTRODUCTION

This is the first session on prairie restoration to be held at the Prairie Conservation and Endangered Species Workshop. It is likely also one of the first sessions on this topic in Canada. For many years we have been talking about and working on components of the prairie ecosystem: the individual species that make up the prairie landscape. Endangered species recovery plans, management plans targeted at specific groups of plants or animals all receive considerable attention. But the native prairie itself, the very basic habitat that all prairie wildlife depends upon, has been largely ignored.

OBJECTIVES

The objectives of this workshop are: 1) to determine what prairie restoration is; 2) to examine why prairie restoration is needed; 3) to explain the importance of prairie restoration using locally collected native seed; 4) to examine the mechanics of restoring native prairies; 5) to identify information needs for more effective prairie restoration in Canada; 6) to present some case studies of actual prairie restoration projects; 7) to establish a network of people practising prairie restoration so that information can be better shared in the future; and 8) to generate an action list of what needs to be done in prairie restoration in Canada between now and 1994.

DISCUSSION

The art of prairie restoration is in its infancy in Canada. Notice that I said "art" not science, for there is very little scientific basis for anything that we do in prairie restoration in this country. Things are somewhat different in the United States where prairie restoration projects have been ongoing for many years. Even in the United States, however, there are very few scientifically based studies of restoration ecology. Most information is still anecdotal or in the heads of a few key people. Much of it is specific to conditions quite different than those on the Canadian portion of the continental prairie.

We can learn a lot from the American experience, and from conventional knowledge in the agricultural and reclamation sectors. Particularly in regard to site preparation, pre-planting weed control, and equipment needs, this expertise is very valuable. When it comes to harvesting native ecotypes, species selection, weed management, and ecological succession in restored prairies, we are in need of developing better information specific to the types of prairie found in Canada.

In the absence of a better definition, let's say that authentic prairie restoration involves the planting of a diverse mix of species native to that particular area, with the seed collected as close as possible to the planting site. Grasses are an important component of the mix, but equally important are various native legumes and other forbs (wildflowers). Local seed stocks (what ecologists call "ecotypes") are important in maintaining the biological diversity and adaptability inherent in any natural population of plants.

It might help to understand what prairie restoration is, by saying what it is not. Prairie restoration is not simply planting grass. To the average person and even many professional resource managers, one stand of "grass" is the same as any other. I seriously question the view that a stand of Alfalfa (*Medicago sativa*) - brome (*Bromus* sp.) or Crested Wheat Grass (*Agropyron cristatum*) is equivalent to, or even resembles, a native prairie. Even a stand of so-called "native" grasses that were originally taken from a limited number of wild stock ancestors, selected for genetic uniformity and ease of germination, released as a commercial cultivar, and then planted hundreds or thousands of kilometres from their point of origin, is not a prairie restoration.

In addition, prairie restoration is not a substitute for conserving existing native prairie areas. Just because we say we think we know how to recreate a prairie, does not give us an excuse for becoming less vigilant in maintaining existing native areas. As anyone who has ever tried to restore a prairie knows only too well, restoration is a difficult, time-consuming, and expensive process. There is no substitute for maintaining, conserving, and managing existing native prairie areas.

In our lifetime at least, even the best restored prairie will only be an approximation of the real thing.

ACTION LIST

For prairie restoration to become more than just a dream in Canada, several things are needed. Firstly, we need more detailed research on the mechanics of restoring the variety of prairie community types. What works in the moist black chernozemic soils of Manitoba's Red River Valley, for tall grass prairie may be quite different than what is needed for the dry short grass prairies of southern Alberta. Research similar to the Tall Grass Prairie Restoration Project is needed for mixed grass, short grass, rough fescue, and sandhill prairie communities. At least three permanent plots in each prairie type should be set up and assessed to determine optimal methods of restoring those prairie types.

Secondly, better methods of weed control need to be developed for all types of prairie restoration. One of the most serious problems faced by restoration professionals is competition with non-native weeds in the initial stages of the prairie planting. Prairie plantings, involving mixtures of slow growing, perennial grasses and broadleaved plants, many of which have quite variable germination rates, confer unique weed control problems. An integrated approach involving cultural, chemical, and biological control methods needs to be researched and developed in consultation with agronomic weed control experts.

Thirdly, additional sources of local ecotypes of native prairie seed need to be developed. At present, there is only one producer of native seed in all of western Canada. With a growing interest in native prairie restoration, the conservation of biological diversity, and restoration projects like Grasslands National Park, the demand will continue to increase. Rather than import large quantities of non-local ecotypes from the United States, we should be developing several of our own native seed sources for each prairie type.

Lastly, there needs to be greater awareness of the techniques and importance of authentic prairie restoration among professional resource managers, wildlife biologists, public land managers, and society as a whole. Production of a prairie restoration manual, with details of how to restore and manage the variety of prairie types would be very useful. It would greatly increase the success of efforts to restore our endangered prairie heritage.

HIDDEN VALLEY RESTORATION PROJECT

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After finding that a portion of its 320 acre wildlife sanctuary at Regina, Saskatchewan had been breached by the plough, the Regina Natural History Society recommended that the land cultivated, approximately 4.4 acres, be returned to a native prairie. It was also felt that this would provide an excellent opportunity to monitor the vegetation as it returns back to a natural state.

The project of restoration began in the fall of 1989. Time was spent in determining the size of the project, the costs, and where the personnel and financial support will come from.

METHODS

The project began with the knocking down of the weed growth. This was done in the early fall of 1989. The second step was the seeding of three native grasses—Streambank Wheat Grass, Sodar variety (*Agropyron riparium* Scribn & Sm.), Northern Wheat Grass, Clark variety (*Agropyron dasystachyum* (Hook.) Scribn.), and Slender Wheat Grass, Revenue variety (*Agropyron trachycaulum* Gaertn.). These were supplied by the Saskatchewan Wheat Pool. There was no harrowing after the seeding. It was allowed to fall down onto the ground as it may do naturally. This seeding was done in the fall of 1989 by Frank Switzer and his son, Ian.

Beginning in the spring of 1990, a weekly survey of the entire area was initiated. The number and species of plants within 20 0.5-metre squares were tabulated weekly. These 20 sample areas were identified in as random as possible a method. This method included general wandering and the throwing out of a wire square. These samples began on May 10 and ended on July 12 since there will be little change in number or species occurring after that date.

In addition to the 20 samples, eight 5-metre transects between the cultivated and uncultivated part of the sanctuary were identified. The transects were spread around the perimeter of the plot. The transects were reviewed and plants were identified along a quarter metre corridor along both sides of the transects. The transects were split equally between the cultivated and uncultivated ground. This was done to view if there was any incursions by native species into the project area during the year.

In order to identify the potential invaders of the cultivated plot, a photographic record of the flowers and grasses within the sanctuary was taken. Species were keyed using recognized taxonomic references (Looman and Best 1987, Spellenberg 1979, Peterson and McKenny 1975).

RESULTS

The primary result of the monitoring was the identification of 17 species that grew in the project area (Table 1). These include, principally, Wild Oats (*Avena fatua*), Aspen Poplar (*Populus tremuloides*), Smooth Aster (*Aster laevis*), Broomcorn Millet (*Panicum miliaceum*), and a species of mustard. There was no movement of native species into the cultivated restoration plot. Wild Oats was the predominant species of the plot (Table 1) but no management of this species was initiated.

The Aspen Poplar seedlings were first noted in the sample areas on May 31, 1990 approximately 30 metres away from the edge and the nearest trees.

On July 5, 1990, a clump of Smooth Asters was noted on the southern side of the plot.

Throughout the entire plot, there was a number of other typical field weed species found dominant on the plot. These included Broomcorn Millet, Tansy Mustard (*Descurainia richardsonii*), Russian Thistle (*Salsola kali*), Red-root Pigweed (*Amaranthus retroflexus*), Lamb's-quarters (*Chenopodium album*), Common Wild Rose (*Rosa woodsii*), Field Toad-flax (*Linaria canadensis*), Field Chickweed (*Cerastium arvense*), and Wild Mustard (*Brassica kaber*) (Table 2).

DISCUSSION

There was insufficient movement or change in the transect samples to determine if change in the border between the cultivated area and the native prairie occurred.

Table 1. Average density of plants species (plants per m^2) found in 20 - 0.5 m^2 plots, on the Hidden Valley Restoration Project on July 12, 1991.

Plant No.	Species	Density
1	Red-root Pigweed (*Amaranthus retroflexus*)	20.2 (1)
2	Smooth Aster (*Aster laevis*)	- (2)
3	Wild Oats (*Avena fatua*)	487.6 (1)
4	Wild Mustard (*Brassica kaber*)	30.4 (1)
5	Shepherd's Purse (*Capsella bursa-pastoris*)	- (2)
6	Field Chickweed (*Cerastium arvense*)	0.8
7	Lamb's-quarters (*Chenopodium album*)	0.4
8	Tansy Mustard (*Descurainia richardsonii*)	6.2 (1)
9	Field Toad-flax (*Linaria canadensis*)	1.0
10	Alfalfa (*Medicago sativa*)	- (2)
11	Broomcorn Millet (*Panicum miliaceum*)	310.2 (1)
12	Aspen Poplar (*Populus tremuloides*)	1.2 (3)
13	Russian Thistle (*Salsola kali*)	4.2 (1)
14	Prickly Sow-thistle (*Sonchus asper*)	- (2)
15	Stinkweed (*Thlaspi arvense*)	- (2)
16	Goat's-beard (*Tragopogon pratensis*)	- (2)
17	Vetch (*Vicia* spp.)	- (2)

(1) These were the most abundant, most frequently found and some of the most commonly found agricultural weed species in the project area.

(2) These species were not found in the sample taken on July 12 but were found in the project area at least once through the summer season.

(3) This species was found in an area approximately 30 metres away from other plants of the same species adjacent to the project area.

After identifying the species that are present on the project area and the likelihood that these species will continue to be found on the area due to the disturbance, it is suggested that there be some means of controlling some of these species, especially the Wild Oats. This management should only be the control of the seed production through harvesting the plant such that no seed has a chance of dropping to the ground. Over time, the seeds already present in the soil will germinate and be depleted. This management will also allow the other grass species to out compete the wild oats and eventually reduce its dominance within the project area. An alternate strategy is to conduct no seed management to see if Wild Oats can maintain itself or if other species will replace it.

It also should be noted that none of the seeded grasses were found in the samples over the summer. This could be due to the slow nature of grass germination and the small size of the sample taken. It is speculated that these grass species will be more prominent on the project area in time.

This project of restoration of native prairie is a long-term program and should not be wholly discounted for not getting immediate results. A valuable baseline of information was obtained in the first year.

Table 2. Plant Species and density (Number per m^2) found by regular sampling of 20 plots on the project area.

Plant[1] No.	May				June				July	
	10	16	24	31	6	14	21	28	5	12
1	11.8	8.4	6.4	11.8	29.4	7.4	19.6	13.6	16.2	20.2
2	-	0.2	0.2	-	-	-	-	-	-	-
3	62.4	195.8	292.4	361.2	12.8	-	-	-	522.2	487.6
4	-	-	39.6	34.6	20.2	20.6	30.8	20.6	36.8	30.4
5	17.6	18.8	0.4	-	-	0.2	-	-	-	-
6	-	-	-	-	0.4	-	0.6	0.2	0.2	0.8
7	0.2	-	0.2	-	-	-	0.2	0.2	0.2	0.4
8	6.6	21.8	23.8	17.4	13.8	21.2	11.6	12.0	17.8	6.2
9	-	-	-	-	-	-	0.6	-	0.2	1.0
10	-	-	-	-	-	0.2	-	-	-	-
11	-	1.8	112.2	74.6	116.0	59.2	160.0	141.4	75.2	310.2
12	-	-	-	1.6	0.2	-	0.8	0.4	0.2	1.2
13	1.0	0.2	1.2	0.4	0.2	0.8	0.2	4.8	2.6	4.2
14	-	-	-	-	-	-	-	-	0.2	-
15	-	-	0.2	0.8	-	-	-	-	-	-
16	-	-	-	-	-	0.2	-	-	-	-
17	-	-	0.2	-	-	0.2	0.4	-	-	-

[1] See table 1 for species names

ACKNOWLEDGMENTS

Volunteer support for the project came from the Gaia Group. Permission to enter the sanctuary and initiate the project was received by the Regina Natural History Society. Financial support for the project principle came from Environment Canada's Environmental Partners Fund. Time committed from the volunteers was included in the calculations of the budget of the project. Support was also given by the Member Initiatives Program of the Saskatchewan Natural History Society and members of both the Regina and Saskatchewan Natural History Societies.

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MIDWEST RESTORATION HISTORY

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The goat prairie on the southwest facing slope behind my dad's barn still exists! As a child in the '50s, my parents warned me not to hike the hill because the sunny, rocky, sandy bluff was home to rattlesnakes. In my years of scampering up the hill, I never saw a Prairie Rattlesnake (*Crotalus viridus*). I suspect they heard me coming as I whistled a happy tune. My climbs were rewarded with Pasque Flowers (*Anemone patens*), Common Wild Roses (*Rosa woodsii*), and Blue-eyed Grass (*Sisyrinchium montanum*), depending on the season. I knew it was a special place; I did not know it was a prairie. Thirty-five years later I returned to see if my childhood memory had survived. Not only was it there, but it had expanded on the slopes where grazing had been eliminated! As in the years before, I saw no rattlesnakes.

I found great hope from that recent experience for what has become my career—plant community restoration. Let me explain how restoration has evolved since those childhood days in the midwest.

Representative of restoration in the decades since my childhood are:

1. 1930-1940s - Ecologists Aldo Leopold and John T. Curtis began planting an educational sampler of Wisconsin plant communities at the University Arboretum. Their prairie restoration is the oldest known attempt to recreate a prairie community.

2. 1950-1960s - Other ecologists, including Peter Schram of Knox College in Galesburg, Illinois described do's and don'ts of prairie restoration and hosted the Prairie and Prairie Restoration Symposium of 1970 which has been followed by the biennial North American Prairie Conference meetings.

3. 1970s - Landscape architects, like Darrel G. Morrison, began to apply ecological findings to their residential/commercial design work. This was a logical link to a landscape architect Jens Jensen, of the early 1900s, who used nature as a model for his work.

4. 1980s - Restorationists, like Ron Bowen of Prairie Restorations Inc., began to emerge due to the demand for practical environmentalism. During this decade the Society for Ecological Restoration, a nationwide group, was begun.

5. 1990s - My own work pulled together the work of all my predecessors, from residential, to educational, to practical roadside application at the Minnesota Department of Transportation (DOT). Other DOTs including Iowa, Wisconsin, Michigan, and Illinois did similar work.

All of these states share parallel roadside history based on the following events:

1. 1960s - The 1965 roadside beautification legislation during the Johnson administration meant that billboards and junkyards would be removed from the landscape and plantings would be added. In his support of restoration, President Johnson stated "Our land will be attractive tomorrow only if we organize for action and rebuild and reclaim the beauty we inherited."

2. 1970s - Roadside management shifted toward an ecological approach due to the pressure of dwindling gas tax revenues. Thanks to economics, ecology was seen as a solution. Until this time, the 1950s agricultural management practice of mowing and spraying to make our roadsides look like our front yards, was the prevailing approach. Operation Wildflower was encouraged by the Federal Highway Administration (FHA) beginning in 1973.

3. 1980s - We saw the continued exploration of the ecological approach with more pressure by wildlife habitat supporters. 1985 saw the passage of the Rural Mowing Act in Minnesota. By limiting mowing of rights-of-way to the month of September, it was believed that birds and small mammals could nest and raise young successfully. On a national scale, the 1987 Wildflower Policy Act administered by the FHA influenced all states

seriously. They were now obligated to spend ¼ of 1% of their landscape budgets on establishment of native wildflowers in any construction project that used federal funds. States still continue to interpret the act differently. In the midwest, DOTs are consistently specifying native forbs and grasses as native wildflowers.

4. 1990 - 1990 brought the official beginning of the Minnesota DOT Wildflower Program. This program was the result of the described history and the Lieutenant Governor's Wildflower Task Force. This task force reported to the Governor in 1988 that preservation and restoration of Minnesota's natural heritage should be incorporated into roadside policy—it was. Since then, the Minnesota DOT has experimented with different restoration techniques like interplanting and preservation efforts including designated Wildflower Routes.

Restoring my childhood memory is more than an ecological solution, or roadside policy for the midwest. It is a solution for the future repair of plant communities throughout the world. Putting back the plants that carpeted the landscape before human disturbance is relevant to reforestation, biological diversity, sustainable agriculture, and many current environmental issues which are much larger than the small goat prairie that began this history. However, that vestige of the past, like others, has much to teach us about future restoration potential in the midwest.

TALL GRASS PRAIRIE RESTORATION PROJECT: PRELIMINARY FINDINGS

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ABSTRACT

The Tall Grass Prairie Restoration Project (TGPRP) was initiated in 1990 by Prairie Habitats, with funding from Wildlife Habitat Canada (WHC) and Hoechst Canada Inc., to determine the optimum methods of restoring tall grass prairie in Manitoba. Seeds from 113 plant species were harvested from relic tall grass prairies in southern Manitoba. Three 1 ha sites, at separate locations near Winnipeg, were prepared for seeding by cultivation and harrowing or rototilling and roller packing. Experimental design compared spring versus fall seeding dates and drilling versus broadcasting seed with mulching, irrigation, supplemental seeding, fertilization, and soil impoverishment sub-treatments. Preliminary results suggests that drilling prairie grass seed results in higher germination rates than broadcasting. Conversely, prairie forbs germinate at higher rates when broadcast. Weedy grasses and overall weed cover are reduced by cultivation prior to spring seeding.

INTRODUCTION

The TGPRP was initiated in the spring of 1990 by Prairie Habitats with funding from WHC and Hoechst Canada Inc. The goal of this five-year project is to determine the optimum methods of restoring tall grass prairie in Manitoba, on lands where this vegetation community no longer exists. The study arose out of recommendations in World Wildlife Fund Canada's Prairie Conservation Action Plan (1988).

STUDY SITES

Three sites in the Winnipeg region were chosen as experimental sites. The first is 4 km south of Ste. Agathe, Manitoba, in the median between two lanes of Provincial Highway #75. The second is in Beaudry Provincial Heritage Park, 10 km west of Winnipeg. The third is in northeast Winnipeg in Kil-Cona Regional Park. The first two sites are reclaimed agricultural fields with chernozem soils. The third is a landfill redevelopment with clay soils.

METHODS

Seed Harvesting

Seed was harvested from relic tall grass prairies in southern Manitoba in 1990. Hand harvesting accounted for small quantities of seed from a wide array of species. Mechanized harvesting, with custom built seed strippers, provided larger quantities of seed from the more common species. More than 200 kg of Big Bluestem (*Andropogon gerardii*) and about 50 kg from a total of 112 other species were harvested. Seeds were processed and cleaned in a variety of manners prior to being sown. Twenty-nine species were used in the basic restoration mixture: 6 grasses and 23 forbs (Appendix 1).

Experimental Design

The two primary variables being compared in this research are seeding date (spring versus fall) and manner of seeding (drilling versus broadcasting). On all three sites, 1 ha plots were laid out on a grid pattern with half of each site to be seeded in the fall and half in the spring. Respective halves of fall and spring seeded plots were seeded by drilling and broadcasting. Each of the resultant ¼ ha plots was divided into 20 equal sub-plots (125 m^2) to allow for additional sub-treatments to be applied. Sub-treatments were applied on 3 sub-plots within each of the 4 major plots. Sub-treatments included straw mulching, irrigation, supplemental seeding (applied in 1990), fertilization, and soil impoverishment (applied in 1991). For brevity sake these sub-treatments will not be discussed further in this paper. A number were discontinued in 1991 and no effects attributable to any of the sub-treatments were apparent.

Site Preparation

Site preparation consisted of cultivation, either by deep-tilling and harrowing (fall 1990) or by rototilling and roller-packing (spring 1991). Plots were harrowed or packed until a firm seed-bed was attained.

Seeding Techniques

A Truax native seed drill was used to drill seed. A known weight of seed, equivalent to 25.2 kg/ha, was added to the seed box. Several passes were made over the entire plot to ensure even coverage and a complete as possible delivery of all seed in the box.

Broadcasting was accomplished by hand from the back of a half-ton truck. The required seed was split into two equal lots. Plots were then covered twice to ensure even coverage. A chain dragged behind helped incorporate and pack the seed. Spring seeded plots were roller packed after seeding. Broadcast seeding rate was twice that for drilling, 50.4 kg/ha.

Fall plots were sown at Beaudry and Ste. Agathe the week of October 20, 1990, spring plots in the week of June 20, 1991. Fall plots at Kil-Cona were sown on October 15, 1991. The spring plot is to be sown in June 1992.

Weed Control

Weed control at Ste. Agathe and Beaudry involved mowing with a tractor mounted, 3-point-hitch, 1.2 m wide rotary mower set at 15 cm above the ground. The sites were mowed twice in 1991, in mid-July and in mid-August. Clippings were left on the plots.

Baseline Environmental Measurements

Snow cover was measured on all three sites in February and March 1991. Monthly temperature and precipitation data were obtained from the Atmospheric Environment Service for the three stations closest to the experimental sites. Soil samples were collected on each site, and subjected to standard soil analysis.

Plot Monitoring

Monitoring of the fall seeded plots began in May 1991. Sampling was done bi-weekly, or as weather conditions permitted, until early September. Spring seeded plots were first sampled on July 8, 1991.

Sampling to estimate plant densities was conducted as follows. A quarter metre square quadrat was placed randomly on each sub-treatment and control sub-plots. All the seedlings of each species were identified and counted. Large numbers of weed seedlings necessitated the use of 1/16 m^2 quadrants for weed counts. Within each ¼ ha plot the number of samples ranged from 6-12 on each sampling date. All data were converted to numbers of plants/m^2.

RESULTS AND DISCUSSION

Baseline Environmental Conditions

Snow cover on all three sites in 1991 was minimal: Ste. Agathe (5 cm); Beaudry (20 cm); and Kil-Cona (12 cm). The period November 1, 1990 through October 31, 1991 had below average precipitation for all three stations. Rainfall in spring and early summer, 1991 was thought to be adequate to promote germination.

There are substantial differences in soil conditions among the three sites. Nitrogen levels were highest at Ste. Agathe, followed by Beaudry then Kil-Cona. Phosphorus was highest at Ste. Agathe, followed by Kil-Cona and Beaudry. No effects attributable to soil nutrient differences between sites are apparent at this time.

Plant Densities

The preliminary nature of these findings warrants only a cursory discussion at this time. For brevity sake, only results from the Beaudry site are presented here. Densities of prairie plants were much lower at Ste. Agathe and there were few apparent trends in the data. At Beaudry mean densities of prairie grass seedlings, mainly Big Bluestem, ranged from 19.6 to 62.4/m^2 (Figure 1). There were no apparent differences between the mean densities of prairie grasses on drilled versus broadcast plots for both fall and spring seeding. This is despite the fact that grass seed was broadcast at twice the rate it was drilled, 44.4 kg/ha broadcast versus 22.2 kg/ha drilled. This suggests that drilling grass seed results in a higher germination rate.

Fall seeded prairie grasses were initially found in higher numbers than were spring seeded grasses. However, relative numbers were approximately the same on both plots by the end of summer. Whether this apparent decline in success of the fall seeded plots

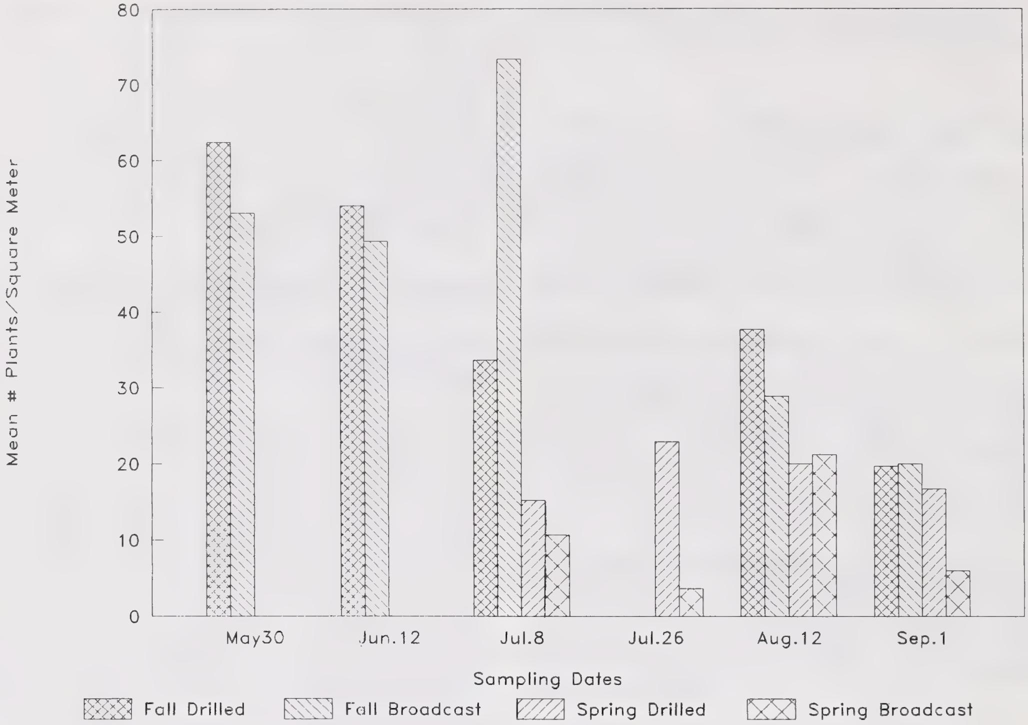

Figure 1. Mean densities of prairie grass seedlings at Beaudry, 1991.

is real or merely sampling error, owing to increased weed cover, remains to be seen.

Mean densities of prairie forb seedlings ranged from 2.6 to 15.7/m^2 (Figure 2). Unlike the grasses, forbs exhibited substantial differences in mean densities attributable to the manner of seeding. In all but one instance, mean densities in broadcast plots exceeded that of the respective drill plots, averaging 3.6 times higher. This is despite seeding rates only twice that for drilling. Broadcasting appears to promote greater germination in forbs.

DISCUSSION

The first season of data gathering on this project has provided some insight into the practical aspects of prairie restoration. These findings are not yet substantiated. Data collection in future years may serve to confirm these preliminary results.

The observed densities of prairie grasses and forbs at the Beaudry site offer tantalizing evidence to support the common knowledge apparent in the literature. Most authors agree that when sowing native grasses the seeding rate for broadcasting should be twice that used for drilling (Rock 1981, Schramm 1978). However, documentation of trials to establish this recommendation are lacking. There is less agreement with regard to forb seeding rates, but the common knowledge now favours broadcasting forb seeds rather than drilling them (Bowen, pers. comm.). Reasons offered as to why the different manners of seeding favour grasses or forbs are numerous and largely untested. The current research may ultimately offer some of the first hard evidence to support the existing body of common knowledge.

Little can be said as yet regarding the relative effects of fall versus spring seeding. Prairie plant densities on fall and spring seeded plots were similar by the end of summer. One effect related to seeding date emerged from the weed populations. Cultivation of the soil

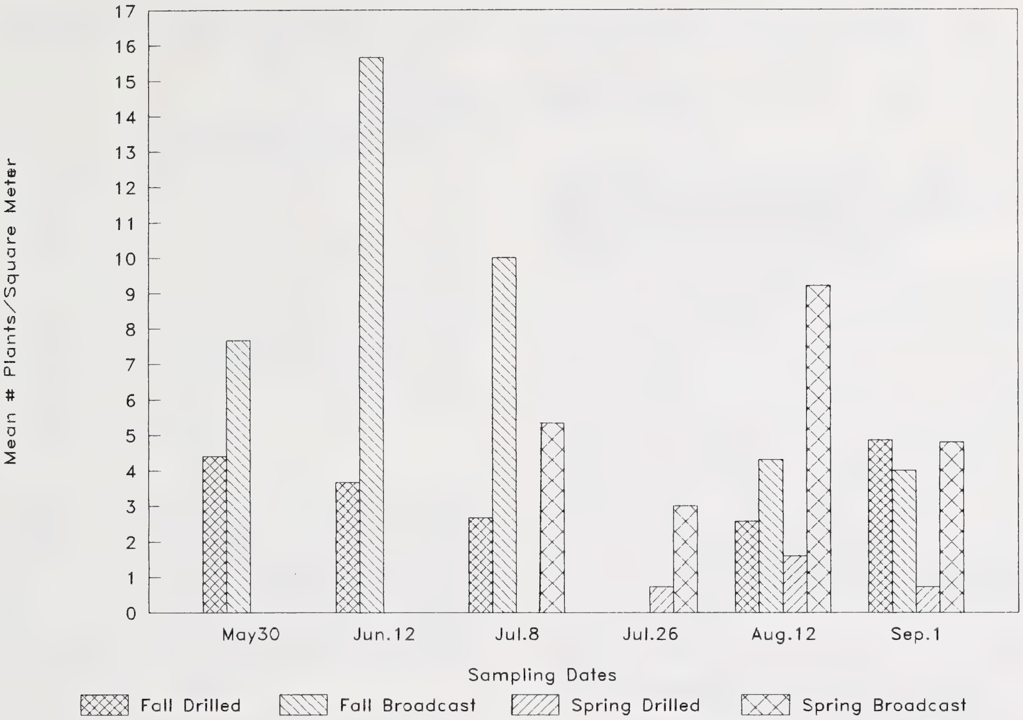

Figure 2. Mean densities of prairie forb seedlings at Beaudry, 1991.

prior to spring seeding resulted in a large reduction in weedy grass densities, particularly Wild Oats (*Avena fatua*), and an overall reduction in weed cover. Better weed control is one reason often stated for promoting spring seeding (Leskiw 1978, Schwarzmeier 1972, Betz 1986).

The TGPRP will continue until at least 1994. Future data collection and analysis, and further experimentation will hopefully lead to an improved body of knowledge on the practice of prairie restoration.

ACKNOWLEDGMENTS

This project was made possible by the financial support of Hoechst Canada Inc., Roussel Uclaf, and WHC. Permission for use of the research sites was granted by Manitoba Department of Highways and Transportation; Parks Branch, Manitoba Natural Resources; and Parks and Recreation, City of Winnipeg.

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Appendix 1. Restoration seed mixture.

Plant Species	Weight of bulk seed (g) sown per 1/4 ha plot Drilled	 Broadcast
Grasses		
Big Bluestem (*Andropogon gerardii*)	4,670	9,340
Indian Grass (*Sorghastrum nutans*)	280	560
Prairie Dropseed (*Sporobolus heterolepis*)	180	360
Switch Grass (*Panicum virgatum*)	90	180
Canada Wild Rye (*Elymus canadensis*)	150	300
Spear Grass (*Stipa comata*)	170	340
Subtotal	**5,540**	**11,080**
Forbs		
Purple Prairie Clover (*Petalostemon purpureum*)	235	470
Stiff Goldenrod (*Solidago rigida*)	43	85
Heart-leaved Alexander (*Zizea aptera*)	35	70
Narrow-leaved Sunflower (*Helianthus maximilianii*)	35	70
Leadplant (*Amorpha canescens*)	100	200
Three Flowered Avens (*Geum triflorum*)	25	50
White Prairie Clover (*Petalostemon candidum*)	65	130
Yellow Coneflower (*Ratibida columnifera*)	18	35
Gaillardia (*Gaillardia aristata*)	23	45
Beautiful Sunflower (*Helianthus subrhomboideus*)	20	40
Meadow Blazingstar (*Liatris ligulistylis*)	50	100
White Cinquefoil (*Potentilla arguta*)	15	30
Smooth Aster (*Aster laevis*)	15	30
Prairie Crocus (*Anemone patens*)	15	30
Rough False Sunflower (*Heliopsis helianthoides*)	10	20
Many Flowered Aster (*Aster ericoides*)	10	20
Graceful Goldenrod (*Solidago canadensis*)	10	20
Black Eyed Susan (*Rudbeckia hirta*)	5	10
Pink Flowered Onion (*Allium stellatum*)	5	10
Northern Bedstraw (*Galium boreale*)	5	10
Bergamot (*Monarda fistulosa*)	5	10
Yarrow (*Achillea millefolium*)	5	10
Alumroot (*Heuchera richardsonii*)	2	5
Subtotal	**750**	**1,500**
Total	**6,290**	**12,580**

* Seeding Rates = 25.2 kg/ha for drilled plots (22.2 kg/ha grasses plus 3 kg/ha forbs)
= 50.4 kg/ha for broadcast plots (44.4 kg/ha grasses plus 6 kg/ha forbs)

PLANT PHENOLOGY: BIOINDICATOR FOR CLIMATE CHANGE

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WHAT IS PHENOLOGY?

Phenology, defined as "the study of the seasonal timing of life cycle events" (Ratchke and Lacey 1985), has a long history. Information collected thousands of years ago in the Orient on the timing of events such as flowering of cherry trees, was used to make agricultural calendars. Carolus Linnaeus, who gave science the naming system we use for all living things, was the father of modern phenology.

In the plant kingdom, phenology generally studies the timing of development of flowers and leaves. "Phenophases" are growth phases which are easily observed, distinct milestones in a species' life cycle. Examples include: bud break, first leaf, first flowering, and ripe fruit. In animals, examples include the timing of arrival, nesting and migration of birds, and hibernation or emergence of mammals.

Plants can be considered as environmental measuring sticks, because they integrate the effects of weather. The advantage of using plants as weather instruments is that they are widespread, and less costly than man-made meteorological instruments.

Temperature appears to be the most important factor affecting the phenology of spring plant development in the temperate zone of the world. The timing of plant development in the first half of the year depends primarily on the amount of accumulated heat (Larcher 1983), which is often expressed in degree-days above a certain threshold such as 5°C. In particular, flowering of most temperate woody species and some perennial herbs is in response to accumulated temperature (Ratchke and Lacey 1985). Plants which flower in response to day length include mainly annual plants and grasses (Beddows 1968).

Caprio (1971) has shown that combining heat sums (degree-days) with solar radiation may give an even more accurate picture of the abiotic factors influencing lilac phenology. Common Purple Lilacs (*Syringa vulgaris*) grown in different areas—Montana, the west coast of the United States, and Norway—all required the same number of solar heat-units to flower.

HOW CAN PHENOLOGY HELP OUR UNDERSTANDING OF PRAIRIE ECOSYSTEMS?

In temperate areas of the world where we see pronounced seasonal changes, the sequence of development of organisms over the course of a year follows a predictable pattern. Once the sequence and average timing is known (after 10 years or more of data collection), this predictability can be used to provide indicators across trophic levels. For example, the appearance of first flowers on wild Saskatoon (*Amelanchier alnifolia*) or on Common Lilac may signal that in five days apple trees will bloom, or in 10 days an insect pest will appear. This data can benefit agriculture, as indicators have been developed for many insects including the European Corn Borer (*Ostrinia nubilalis*) (Hopp 1978), the Elm Bark Beetle (*Scolytus maltistriatus*), grasshoppers, and the Alfalfa Weevil (*Hypera postica*). Besides crop and pest management in agriculture, phenology has many other applications including forestry, remote sensing, human health, tourism, and even forensic law (Beaubien 1991a).

Phenological data allows us to monitor changes in climate through changing phenological patterns; since spring-flowering plants react to heat accumulation times, earlier and earlier flowering would be observed if the predicted global warming produces warmer winter and spring seasons. Phenology also allows us to track the effects of weather extremes on plant development. But it is important that we start collecting this baseline phenology data now!

WHAT PHENOLOGICAL DATA EXISTS FROM THE PAST?

In Europe, international networks of phenological observers date back two centuries (Hopp 1974). Presently many European countries have networks of volunteers coordinated by their national meteorological departments. The data collected is largely used to assist agriculture in various ways including crop protection, and land zonation. Volunteers among the general public as well as school classes record phenophases for both native and cultivated plants. This information has permitted fine-scale mapping of Switzerland and

Germany, which show how areas differ in their potential for agriculture and horticulture.

In 1959, an International Phenological Garden program was established in Europe, using clones of woody plants to eliminate phenological variation due to genetic influences. By 1987, 62 gardens were reporting data on these cloned species, on native plants and on weather. Lauscher and Roller (1980) examined the previous 17 years of data from 18 gardens in Norway and Austria for evidence of changes in timing. They found a slight lengthening of the growing season, with spring leafing occurring on average 0.36 days earlier, flowering 0.33 days earlier, and autumn phenophases 0.20 days later.

In the United States, regional phenology projects coordinated through the United States Department of Agriculture were launched in the 1950s. Networks of volunteers recorded phenology of flowering and leafing for cultivated species: Common Lilac and two honeysuckle (*Lonicera* spp.) cultivars. Dr. Joseph Caprio, based in Montana, began his survey in 1956 and by 1972 had 2500 observers across the western states (Hopp 1974). Presently he has about 500 observers, and he has observed earlier than average flowering of Common Lilac through much of the 1980s (Caprio pers. comm. 1990). Funding for the survey in the eastern United States has recently come to an end, though about 50 observers still submit data and 30 years of phenology data is available from the present coordinator, Mark Schwartz (pers. comm. 1992).

To my knowledge, these long-term data still await analysis for correlation with climate change. The existing databases will provide an invaluable baseline against which to compare future trends in global warming. Long-term monitoring should be a major priority for environmental research, so that change will be evident to us in future! As Likens (1983, page 241) noted: "Many, if not most of the current environmental problems, (e.g., acid rain, toxic wastes, etc.) would not be controversial issues if there had been long-term data from which trends and effects could be determined."

Canadian interest in phenology began in 1890 with a national phenology project started by the Royal Society of Canada and carried out until at least the 1920s by the Botanical Club of Canada. These records were published annually in the Transactions of the Royal Society of Canada. Since then Canada's only major extensive survey has been the involvement of volunteers in the eastern provinces in the eastern United States regional phenology project. One interesting intensive phenology study carried out close to the site of this conference, Brandon, was by Norman Criddle (1927) who published the average first flowering dates and time required to set seed for 400 native species.

Extensive phenology studies using a volunteer network of observers began in Alberta in 1973 (Bird 1974) with a 10-year study carried out by Dr. Charles Bird through the Federation of Alberta Naturalists. Starting with flowering observations of 100 native wildflowers, Dr. Bird whittled the list down to 12 "key" phenology species. All are native perennials, easy to recognize, widespread, and with a relatively short and consistent flowering period.

Using these 12 species and adding three more to increase representation from northern Alberta, I launched a new Alberta survey in 1986, and subsequently have received data from about 200 observers annually. The 15 species in flowering sequence are: Prairie Crocus (*Anemone patens*), Aspen Poplar (*Populus tremuloides*), Early Blue Violet (*Viola adunca*), Golden Bean (*Thermopsis rhombifolia*), Saskatoon, Star-flowered Solomon's-seal (*Smilacina stellata*), Choke Cherry (*Prunus virginiana*), Wolf Willow, (*Elaeagnus commutata*), Yellow Pea Vine (*Lathyrus ochroleucus*), Northern Bedstraw (*Galium boreale*), Twin-flower (*Linnaea borealis*), Common Yarrow (*Achillea millefolium*), Western Wood Lily (*Lilium philadelphicum*), Brown-eyed Susan (*Gaillardia aristata*), and Fireweed (*Epilobium angustifolium*). Observers are sent "Alberta Wildflowers," a 24-page publication which illustrates the plants and explains when and how to observe. They return their data sheets at the end of the growing season with the dates when first flowering, mid- or 50% flowering, and full flowering occurred for the species they observed.

For my Masters research (Beaubien 1991a), I tried a number of mapping techniques to illustrate the flowering progression of each species across Alberta. The most successful technique was using the Geographic Information Systems program SPANS (Spatial Analysis System) (TYDAC Technologies 1989).

Mapping showed a general trend in flowering starting in a southeast-northwest corridor, with flowering occurring first in southeastern Alberta, and later heading northeast, north, and southwest into the mountains.

The earlier flowering influence of the city "heat islands" was evident. Once a denser network of observations is available, and many years of data are averaged, the resulting maps will provide valuable ecoclimatic data to show how areas of Alberta differ in growth potential.

With global warming, plant populations will be affected. Changes in plant distribution will likely be most observable at the north and south boundaries of their distributions. The phenology network will be of great value to observe and record plant population dynamics, for the 15 key phenology species and any others requested. Ideally information should be gathered on a whole phenosequence of wildlife development for different regions, integrating the phenology of plants with that of microorganisms, insects, birds, mammals, etc. One of the key recommendations of the United States Regional Climate Centres on the subject of climate change, is to strengthen their deteriorating climate observing network, to allow them to quantitatively measure changes in climate. The Alberta phenology network can assist the Canadian Atmospheric Environment Service in additional climatic coverage of the province.

HOW CAN PHENOLOGY HELP PROMOTE A SUSTAINABLE PRAIRIE ENVIRONMENT?

This survey offers an excellent educational opportunity for the public, young and old, to learn first hand about the relationships between plants (and insects, etc.) and climate (Beaubien 1991b). This increased interest and awareness provides incentives to care about native habitats and can only lead to wise stewardship of our remaining prairie environments. In the southern Canadian prairies, 70% of the average cattle farm is still native grassland (Trottier 1992), so there is much habitat left well-suited to this phenology study and that needs to be preserved. Participation by farmers and ranchers in this study will improve communication between them and the conservation and research community.

Funding is currently being sought to promote and expand this program in Alberta. It would also be very valuable for the prairies and Canada to then extend the survey nationally, and to link up with databases in the United States.

ACKNOWLEDGMENTS

This project has been carried out through the University of Alberta, and has received funding from the University of Alberta Botany Department (Dr. K. Denford's [Natural Sciences and Engineering Research Council] grant), the Canadian Circumpolar Institute, and the Recreation, Parks, and Wildlife Foundation. Thanks for supervision to Dr. W. Moser and Dr. K. Denford, and for mapping and analysis assistance: Dr. D. Johnson, Agriculture Canada, Lethbridge.

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PRAIRIE ECOSYSTEM SUSTAINABILITY AND CLIMATIC VARIATIONS

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ABSTRACT

The nature of the relationships between climate and the prairie agroecosystem is explored by means of a review of prairie climate impact assessments. The assessments have examined the impacts of both past climates and possible future climates. Although the potential effects of global warming on prairie ecosystems have not yet been significantly researched, some examples are provided. Also, the impacts of past climates provide an indication of sensitivities of systems to climate and of the need for improved adaptation. Examples of numerous and often serious effects of climatic variations are provided by Wheaton and Arthur (1989), for example, who examined the environmental and economic impacts of the 1988 drought. Possible climatic change impacts have been assessed for a few sectors in the Canadian prairie provinces, including agriculture (e.g., Williams et al. 1988, Arthur 1988), water resources (e.g., Cohen 1991), forests (e.g., Wheaton et al. 1987), and wetlands (e.g., Woo 1991). Issues addressed include land degradation, biomass productivity, and climatic zonation. Questions regarding the nature of prairie sustainability through future climatic variations are raised. The threat of human induced climatic change increases the need to increase the knowledge of these linkages and to promote a more sustainable prairie environment. A project regarding adaptive strategies for reducing the uncertainties associated with a variable and changing climate in the Canadian prairie provinces is outlined. Adaptation, in this context, means the harmonization of human activities and ecosystems with a variable and changing climate for sustainable development. Adaptation to climatic change requires proactive planning, anticipating the future, providing ourselves with as many options as possible, both today and in the future. Learning to better adapt today to a variable climate puts us in a better position to respond tomorrow to significant changes in the present patterns of climate. Adaptive strategies will better enable us to maximize opportunities and positive impacts, and to minimize constraints and negative impacts (Parry et al. 1988).

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INSECTS AND CLIMATE CHANGE: PROSPECTS FOR POPULATION CHANGES AND IMPLICATIONS FOR ENVIRONMENTAL QUALITY

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INTRODUCTION

Ecosystems and agricultural systems share a reliance on climate to provide the energy and conditions that are necessary for productivity and survival. There has been considerable speculation regarding the fate of these systems under various scenarios of global climate change. This is a matter of special concern in high-latitude continental regions such as the Canadian prairies, in which changes in climate might be predicted to cause important changes in the resilience and geography of wetlands, rangelands, forests, and cropland.

The regional effects of global climate change on prairie biomes will not be limited to vegetation and vertebrates. Insects are also strongly influenced by weather and vegetation, and are prominent features of ecological systems, accounting for a large part of the total diversity. Their abundance and timing also make them important food sources for vertebrate wildlife, and as pollinators they directly affect productivity and continuity in both native and crop systems. Their sequestering of a significant portion of the biomass, combined with recurring population explosions, give them significant rôles in the trophic dynamics of ecosystems, and brand them as pests in many agricultural contexts. Consequently, insects may affect issues of prairie conservation directly, in their capacity as important ecological residents, and indirectly through the impact of some pesticides used for their control.

Climate and weather are especially important factors in the lives of insects native to prairie biomes. As climates change, both in long-term mean values of climate and short-term variability of weather, insects will respond according to their present adaptations to the physical environment. Short generation time and high rates of mobility allow prominent insect species to react quickly to climate change, and become more common in new environments that open up by shifts in the range and timing of temperature and moisture. This result makes possible the use of insect fauna as bioindicators: the first evidence of a lasting ecological reaction to climate change may appear among the insects. The close relationship of insects to weather and climate also portends new problems regarding the geography, intensity, and potential impact of future insect control measures. These questions and issues have resulted in the recent initiation of research on the impact of climate change on insects.

THE NAT CHRISTIE FOUNDATION CLIMATE CHANGE RESEARCH PROJECT

A five-year project, starting in January of 1992 and involving a total of nine researchers at the University of Lethbridge and the Lethbridge Research Station, was designed to determine the probable impact of climate change on agriculture in Alberta. The principle component of the Nat Christie Foundation research project characterizes crop growth and its interaction with soils and pests, primarily insects. Models of dryland and irrigated crop production, with appropriate insect pest components, will be used to forecast possible problems and opportunities under various scenarios generated by the general circulation models of climate change. There are a number of generalized crop models, typically driven by temperature and photoperiod, and controlling the partitioning of carbon. Plant biomass accumulation, both grain harvest and whole plant yield, is driven by solar radiation, moisture availability, and, to a lesser degree, temperature. Cultivar differences in crop models can be modelled by modifying the appropriate coefficients relating development and photosynthesis to environmental parameters. Once appropriate crop models have been developed, the insect factor will be added. The impact of insect pests on crops is primarily negative, but not always timed in the same way or of the same intensity. Two insect models and a crop/insect interaction model will be utilized. The main insect model will detail the dynamics of the pest populations, so that changes in species, age, distribution, and abundance may be simulated. A population model of this type consists of differential equations that model insect stages and resulting population growth, and includes newly developed and parameterized functions of survival, development, and reproduction as functions of time, temperature, and other relevant environmental variables. Within a given year of interest, this model will simulate the impact of weather and related variables on population age, density, and activity. The output of a long-term spatial version (i.e., couched in a geographic computer modelling system) of this model will describe the expansion and longevity of insect outbreaks, and the consequences for crop production in these areas. The approach will be applied to existing and severe insect pests, such as grasshoppers and cutworms, and to hypothetical insect pests that could become established under various scenarios of changing climate and cropping practice. The next step in the exercise will be to forge linkage between the insect pest submodels and the crop models, either via direct combination of subroutines, or through construction of a database of insect outbreak scenarios. An additional application of this process model will be to screen the economics and long-term effectiveness of scenarios of alternative control practices, designed to promote sustainable agriculture and identify opportunities for reducing insecticide usage. For example, is it possible to anticipate and recognize changes in insect distribution and abundance that have resulted from climate change? Can we identify areas in which to employ intensive scouting to prevent insect infestations from spreading? Can we identify climatic zones in which the activity of natural enemies, like fungi that occasionally cause diseases of insects, could be enhanced?

The second insect modelling approach planned is essentially statistical or empirical. This is not a competing method that will preclude a process modelling approach, but one that will provide reasonable estimates of expectations and provide a means of testing and refining the process models. A geographic information system database of grasshopper data will be used to characterize spatial and temporal autocorrelation, and to describe the insect population responses that have been observed following certain patterns of weather. The basic premise of the empirical approach is that the insect populations will respond to climatic variability and change in a way that is similar to their responses in the past. One additional output of this second approach would be a concise historical description of the meteorological conditions that have influenced grasshopper outbreaks in this century. Such a quantitative description would have the additional benefit of testing and improving insect forecasting methodology.

BACKGROUND ON GRASSHOPPERS

An example of how climate change might alter the pattern of insect outbreaks can be seen in the case of recurring grasshopper infestations. Although the outbreak of the mid-1980s has since declined to more moderate levels, grasshoppers remain the most destructive pests of cereal crops and range grass in many parts of the Great Plains and Prairies of the United States and Canada. The most severe economic losses are caused by the four major grasshopper species known to attack crops: *Melanoplus bivittatus*, *M. packardii*, *M. sanguinipes*, and *Camnula pellucida*. Grasshoppers are not new or introduced pests (in fact their depredations in the 19th century were worse). Their adaptations to weedy succession areas equipped them to become a periodic feature of cropland.

The potential for crop loss is significant in most years, but damage from these pests can be particularly extensive during peak outbreak years. The present outbreak is a typical one in which grasshoppers rapidly increased in abundance in crop and grassland regions, and then slowly declined. There have been roughly seven outbreak peaks of several years each since monitoring began in the 1920s. In high-density areas, grasshoppers remove forage that would otherwise feed livestock, and threaten cereal and oilseed crops throughout the season. They can kill newly emerged seedlings, and their chewing in mid-season reduces subsequent yields. Just before harvest they may feed directly on the ripening grain. In some years, soil erosion resulting from the destruction of cover crops by grasshoppers has been reported.

For now, the only available response to significant grasshopper infestations, other than doing nothing and suffering crop loss, is wide-scale spraying of insecticides. For example, provincial sales records indicate that in Alberta in 1985, a total of 410,000 litres of insecticide (from 6,600 purchases) were applied to 780,000 ha of agricultural land. One of the research challenges in the management of this pest is to substantially reduce the amount of chemical insecticide required to ameliorate these infestations, in part through anticipation of the changing pattern of application that may occur under future climates and cropping practices. For example, a northward increase in the growing season accompanied with higher temperatures and periods of reduced moisture might indicate that greater use of insecticide would occur in these areas. Advance warning would reduce the negative impacts on sensitive areas. Advance notice of where outbreaks will occur may even aid in the development of natural control methods, for example, application of weather-dependent pathogens that cause grasshopper diseases, or targeting regions in which natural controls can be encouraged.

It is well-known that several consecutive years of warm, dry weather have preceded the major grasshopper outbreaks, but in many cases the details of the relationship are unknown. To predict the future distribution and abundance of insects, it is necessary to identify the climate variables that significantly affect their survival, growth, and development. Some of these studies have been completed or are underway in a number of locations. The next steps are to construct reasonable models of the reaction of the insects to weather and climate, and then to apply climate forecasts to the insect models in order to generate a predicted map of future pest activity, as discussed above. These insect-crop-climate models are expected to reveal significant changes in crop protection scenarios, because the dominant insect pests are strongly influenced by the quantity and timing of heat and moisture. For example, predictions based on the Goddard Institute for Space Studies general circulation model indicate a longer growing season and an increase in the occurrence of drought (Stewart 1990). These changes, coupled with a 4^{o}C increase in average temperature, may be expected to result in more frequent outbreaks of grasshoppers, and a possible northward shift in infestations of cutworms and aphids, but precise estimates will require more explicit comparison of insect ecological requirements and predicted climate change pattern (it can become too hot and dry even for grasshoppers). However, depending on the model used, a doubling in CO_2 can be expected to increase surface temperatures between 3^{o} and 7^{o}C, with increases of up to 30% in rainfall in some regions of Alberta.

Models of the impact of climate change on cropping practice are also required, because the economic loss due to insects such as grasshoppers, cutworms, and aphids is dependent on the crops and cropping practices selected.

CASE STUDY: GRASSHOPPER OUTBREAKS IN ECOREGIONS OF ALBERTA

When beginning a study of insects and the probable impact of climate change, it is instructive to first look for empirical evidence that would help develop or validate models of how the insects have reacted under various climate regimes or ecoregions. In order to reorganize the Alberta grasshopper database along climatic divisions, I divided and summarized 22 years of grasshopper survey data by ecoregion.

The various ecoregions and ecodistricts of Alberta are delineated on the basis of physical and biological variables that affect vegetation and wildlife native to each area. The classification of Alberta ecoregions was described by Strong and Legatt (1981) and has been recently updated (Strong 1991). Definitions are based on separation according to vegetation physiognomy, soil genetic composition, surface features, soil classification, soil texture, slope, and climate. Climatological classification is based on weather measurements, including expected values, ranges, and timing of temperature and precipitation. The Prairie Ecoprovince is divided into 4 ecoregions (in order of increasing moisture regime): Dry Mixed Grass, Mixed Grass, Fescue Grass, and Aspen Parkland, all of which are zones that have periodically hosted grasshopper population explosions. Grasshoppers are less common pests in the Boreal Ecoprovince and in the Cordilleran Ecoprovince, so these were not included in this study.

In theory, ecological zonation can be usefully applied to analysis and prediction of the activities of plant pests for two main reasons. First, the types of vegetation exposed to attack vary among ecological zones, and the availability of food or a host plant is a key factor determining pest distribution and population dynamics. Second, the pests themselves react ecologically to some of the same variables used to define ecological zones, as discussed above. This information, once formalized and validated, could be used to forecast changes in endemic pests as weather changes, or to predict the likely spread and subsequent distribution of introduced pests (such as is the aim of the Australian climate-matching program CLIMEX; Sutherst 1991). Forecasts of damage from pests of economically important vegetation are typically based on analysis of the ecological requirements for their survival and growth, and determination of the conditions which will allow individuals to prosper and populations to expand. Some of these ecological requirements are easily measurable, often abiotic, factors that have been used to define ecoregions, and therefore, standard ecoregion classifications and analytical methods may add predictive and explanatory power to pest risk assessment models. If pests react ecologically to some of the same variables used to define the zones, this information can be used to predict the likelihood of pest establishment and growth, both for new or introduced pests and for established pests that have been perturbed by environmental change.

Although the most powerful application of the principles of ecological zonation to prediction of the activities of crop damage will be through the use of process models of the ecological requirements of the pest, analysis of historical data can provide useful evidence of differences in pest performance among ecological zones. In the example below, the dynamics of two decades of grasshopper infestations in four ecoregions of Alberta are shown.

The comparison was possible because of the existence of the grasshopper survey database. Timing is important in grasshopper control, and advance warning of changes in the geographical pattern and severity of outbreaks is required to plan control measures. To meet this need, annual surveys of grasshopper abundance in Alberta are conducted. The method of sampling and mapping was standardized in 1932, updated in 1970 (Smith and Holmes 1977) and combined with geographic information system technology in 1987 to produce annual Alberta grasshopper forecasts (Johnson 1989a). Agricultural field personnel conduct detailed surveys each year in early August when most grasshoppers are in the adult stage. Around the end of July at each of up to 2,000 randomly selected locations per year, trained surveyors (permanent staff of the Alberta Agriculture Service Board) record the vegetation type and grasshopper counts in 100 m transects along the roadside, and in similar 100 m walks through the adjacent field. A summary is used to produce maps forecasting the risk of crop damage for the coming year. Similar surveys are conducted in Saskatchewan and Manitoba.

ANALYTICAL METHODS

The grasshopper survey database, consisting of observations at over 21,000 sites, was subdivided according to the ecoregions defined by Strong (1991). The site records were ordered by latitude and longitude, and assigned an ecoregion value (using SPANS [Spatial Analysis System], SAS [Statistical Analysis System], and original computer software). Mixed model analysis of variance of the log-transformed grasshopper counts was applied to compare differences among years and ecoregions. Also included in the ANOVA (Analysis of Variance) model to predict grasshopper density were the counts from the nearest site from one, two, and three years before, for each site.

RESULTS AND DISCUSSION

When the grasshopper survey records are divided and plotted according to ecoregion, it is clear that the outbreaks differed in intensity and even in timing in the different biomes (Figure 1). The analysis of variance indicated that ecoregion was a highly significant

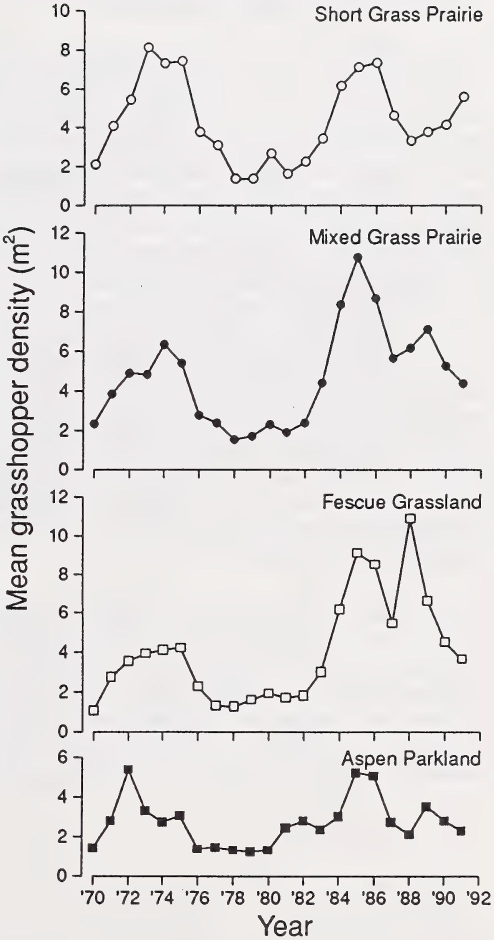

Figure 1. Average roadside grasshopper counts from the Alberta grasshopper survey database. Samples sizes (numbers of survey sites) of the four ecoregion plots are as follows: short grass prairie - 6,736; mixed grass prairie - 5,583; fescue prairie - 2,226; aspen parkland - 5,727.

factor accounting for differences in densities of grasshoppers over time, even after the effects of the previous three years population density were removed. This means that the abundance of grasshoppers depended not only on the previous population density, but was strongly effected by regional environmental variables (primarily the timing and availability of heat and moisture). Differences in timing and severity of the grasshopper outbreaks are clearly visible in summary plots (Figure 1), and the significance of the ecoregion factor persisted even when the Aspen Parkland ecoregion was removed from the analysis, and when the 1970s were analyzed separately.

Ecoregion differences are apparent even in the most recent years (Figure 1). For example, the recent declines in the outbreak did not occur as quickly or in the same pattern in all ecoregions (note the increase in Short Grass Prairie). The distribution may have changed over time. Although the outbreak of the mid-1970s was most severe in the Short Grass Prairie ecoregion, the average grasshopper population density in the mid-1980s was greater in the Mixed Grass Prairie ecoregion. Further analysis is in progress to determine whether this ecoregion shift was related to a shift in moisture and temperature, which could indicate that the climatic component of the definition of ecoregion definitions may have changed during this period. Are ecoregions already moving? In any case, the results indicate that the extent and even the timing of grasshopper cycles varies among ecoregions, and determination of the reasons may help to predict the response to climate change.

Mechanisms may be identified to explain the differences in insect outbreak dynamics among ecoregions, or it may be that the causes are more complex and changing. Overlay and statistical methods offer useful evidence and comparisons regarding the geographic dynamics of pests (e.g., soil type and texture, Johnson 1989b), but particular mechanisms must be hypothesized and tested with more direct methods. This is the challenge of the next step in research on insect outbreaks and climate change.

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3. PRAIRIE CONSERVATION ACTION PLAN

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PRAIRIE CONSERVATION ACTION PLAN IMPLEMENTATION IN SASKATCHEWAN

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Before looking at where we are with respect to the plan I wish to make some general comments on plan implementation. In looking back six years the progress is impressive.

The Prairie Conservation Action Plan (PCAP) was a product of World Wildlife Fund (WWF) Canada's Wild West program, a three year, $600,000 funding initiative. The plan for Wild West was announced at the Edmonton Endangered Species Workshop, the first time those concerned about prairie endangered species and spaces met to discuss prairie conservation. Essentially the 10 goals of the PCAP lay out three main courses of action: endangered species recovery, a system of protected areas, and program integration or sustainable development. The goals elaborate on and provide supplements to those directions.

When WWF initiated the Wild West program, active work on endangered species was just starting in Saskatchewan. The species were protected, and some special actions like protection of pelican colonies had been carried out, but there was no systematic identification of problems and development of recovery efforts for threatened wildlife.

The Wild West program was a significant stimulus to that process both by bringing people together to discuss problems and approaches and by providing some dollars for cost shared projects. During the same period the National Wildlife Directors were moving to create RENEW (Recovery of Nationally Endangered Wildlife) and the whole endangered species area was rising in public profile. By the time the PCAP was released, the species part of its thinking was ingrained in our thinking and we no longer needed to refer to a plan.

Unfortunately, the spaces approach showed less success. In part this was because wildlife agencies currently operate from a species mandate. We protect habitat because it is important for a certain species rather than its basic ecological value. Hence we were not in a good position to pursue creation of a series of ecological protected areas. Large areas, of course, are covered in our parks systems plan, which is committed to a park in each of our natural regions. Saskatchewan Environment has the responsibility for broad ecological protection through ecological reserves, but reserves, like parks, have a high level of protection and will not be implemented to cover 10% of agricultural Saskatchewan by 1994.

The recommendation for a system of protected areas by habitat subregion was therefore, allowed to fade from our agendas because it didn't fit into any existing program. We have protected a lot of land toward meeting the goals of the PCAP as I will show in a moment, but it was not because of the PCAP and, as a result, there are gaps. In truth I cannot point to any new actions on spaces which can be directly linked to the PCAP.

This does not mean the plan has been without value. The thought going into the plan certainly helped focus our thinking on prairie conservation and increased the commitment of key players. The PCAP contributed to the rising concern for prairie conservation and thus has been useful.

However, to evaluate the implementation of the plan, a feedback loop is necessary to check regularly on progress against the objectives. Except for this meeting, there has been no follow up or checking on progress by WWF or any of the provincial nongovernment organizations in Saskatchewan. We have thus failed in one of the basic principles of planning—regular checks on progress—and the PCAP has tended to slip out of people's minds.

In conclusion, we have made progress as I will now briefly summarize. But as with any plan, more regular follow up, prodding, and support would increase our success. In that regard the current WWF endangered spaces campaign with annual follow up is a step in the right direction.

Now to a closer review section by section.

IDENTIFY THE REMAINING NATIVE PRAIRIE AND PARKLAND

The Terrestrial Wildlife Habitat Inventory has essentially accomplished this task. Accessibility of the inventory and potential for updating are being improved as data is entered in the Wildlife Branch (Wildlife Development Fund [WDF]) geographic information system. This goal has been achieved, however, the product needs updating. Additional work on this goal could involve updating the data and determining the quality of the vegetation on the lands identified. More detailed data will be provided by the Nature Conservancy Data Centre which opens in Regina in March 1992.

PROTECT ONE LARGE SAMPLE OF EACH OF THE FOUR MAJOR PRAIRIE ECO-REGIONS

Agreement with Canada on establishment of the Grassland National Park and current acquisition, by the Canadian Parks Service, of land for the park area, is providing the large mixed grass reserve called for in the plan. Moose Mountain Provincial Park, a long standing area comprised of 96,989 acres and set aside in 1931, provides a large aspen parkland reserve.

ESTABLISH A SYSTEM OF PROTECTED NATIVE PRAIRIE ECO-SYSTEMS ACROSS THE PRAIRIE PROVINCES, INCLUDING REPRESENTATIVE SAMPLES OF EACH ECO-REGION AND HABITAT SUB-REGION

There has been no systematic effort to ensure we meet the goal of protecting lands in the 114 sub-regions. However, there is substantial acreage being protected throughout the province.

At present, of the 111 habitat subregions in the prairie and parkland of Saskatchewan nine have more than the 10% goal in protected status. We have more than 500 ha and less than 10% of another 68 subregions protected and less than 500 ha protected on the remaining 34 sites. Of those 34, seven have more than 10% of their land with sympathetic agencies, that is either in PFRA pastures or provincial Crown land with a policy currently in place to retain it for agriculture. Thirteen of the 34 have more than 500 ha in that status. Thus, although not really a secure protection, these areas have some potential to be considered protected through agreements or extensions of the Critical Wildlife Habitat Protection Act (CWHPA). On 14 sites there is essentially no, or at least less than 500 ha of land with any form of protection. But on at least five of these sites there are 500 ha or more of Crown lands which might be suitable protected areas, but all are currently leased for grazing.

Although this progress in protecting habitat subregions is not bad, there are gaps and the gaps are there for a good reason. These lands were not protected because of the PCAP. Not one acre. The groups that are influential and effective in getting habitat protection have been hunters groups. They have been the primary push behind, and the major contributors to, our protected areas in agricultural Saskatchewan, the 1.9 million acres in the CWHPA and 115,000 acres acquired by the WDF. Parks and protected areas are very important in certain regions and responsible for some of the areas where we exceed 10%, but have not provided the extensive coverage of the programs designed for game management.

If there is a lesson in this it is that our endangered spaces type efforts on the prairies might be most effectively tied to game management's main habitat programs. Secondly, the hunter's lobby remains influential. I think we want to ensure that the endangered species and spaces people form common goals with hunters groups whenever possible to maximize effectiveness.

PROTECT PRAIRIE ECO-SYSTEMS AND HABITATS BY PREPARING AND IMPLEMENTING HABITAT MANAGEMENT PLANS FOR ALL PUBLIC LANDS

Management plans are prepared or being prepared for many public lands including parks, wildlife lands, and some PFRA pastures.

PROTECT AND ENHANCE POPULATIONS OF PRAIRIE SPECIES DESIGNATED NATIONALLY OR PROVINCIALLY AS VULNERABLE, THREATENED, ENDANGERED, OR EXTIRPATED BY IMPLEMENTING RECOVERY AND MANAGEMENT PLANS

Saskatchewan is working through the Committee for RENEW to develop recovery plans for all current threatened and endangered species. These are scheduled to be completed by 1993. Some of these plans are already completed and are being implemented, i.e., the Swift Fox (*Vulpes velox*) release program.

The Saskatchewan Endangered Species Fund has supported 16 projects for conservation of threatened wildlife in Saskatchewan. Total value of these projects has been $255,488.

Habitat for threatened, endangered, or extirpated species found on Crown lands can and has been protected under the CWHPA. Follow up can be quick. Many of the areas where Piping Plover (*Charadrius melodus*) were found in spring 1991 on the international census have been mapped as critical habitat and efforts to provide some protection to these sites are under way.

ENSURE NO ADDITIONAL SPECIES BECOME THREATENED, ENDANGERED, OR EXTIRPATED

This goal is almost impossible to achieve as new species continue to be designated by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) due to better knowledge rather than worsening situations. Our major strategies involve use of environmental impact legislation to screen potential adverse impacts. To aid this process the Wildlife Branch provided Saskatchewan Environment and Public Safety with a list of vulnerable species which could become threatened or endangered if adversely impacted.

We have been working with Canadian Wildlife Service to identify and protect critical areas for shorebirds, loss of which could endanger these species.

The new Conservation Data Centre will collect data on species and ecosystems and make it available to businesses to improve their ability to assess environmental impact and thus ensure that new development will not produce additional threatened species.

ENCOURAGE GOVERNMENTS TO MORE EXPLICITLY INCORPORATE CONSERVATION OF NATIVE PRAIRIE IN THEIR PROGRAMS

The Round Table on the Environment and Economy produced the Saskatchewan Conservation Strategy, still in draft form, which seeks to focus efforts by government, industry, interest groups, and individuals to achieve sustainable development in Saskatchewan.

Saskatchewan has been asked to join the proposed new federal-provincial Agri-food Accord on Environmental Sustainability. As a partner to this accord, the department will seek to incorporate wildlife conservation into the new and modified agricultural policies.

ENCOURAGE BALANCED LAND USE ON PRIVATE LAND THAT ALLOWS SUSTAINED USE OF THE LAND WHILE MAINTAINING AND ENHANCING THE NATIVE BIOLOGICAL DIVERSITY OF THE PRAIRIE

The department and Saskatchewan Wetlands Conservation Corporation are continuing efforts to influence agricultural practices to ensure better soil conservation practices and changes in the municipal taxation system. The department continues to support Operation Burrowing Owl (*Athene cunicularia*) and the Saskatchewan Wildlife Federation's Wildlife Tomorrow Program, both promoting private stewardship of lands.

PROMOTE PUBLIC AWARENESS OF THE VALUE AND IMPORTANCE OF PRAIRIE WILDLIFE AND WILD PLACES

The province is the national leader in implementing Project Wild throughout the school system. All education students at both Saskatchewan universities are now trained in Project Wild and more than half of our teachers have the material. We also work in other areas including soil conservation, urban wildlife initiatives, and media coverage.

PROMOTE RESEARCH RELEVANT TO PRAIRIE CONSERVATION

Little progress has been made toward creation of a grassland research centre. Endangered species research is flowing from recovery teams and plans, other research is tending to come from the traditional directions. We talk, at recovery teams and other places, about the need for some long-term ecological studies, but so far we have not been able to develop such a research program.

To close, I wish to take a look forward to what may happen in the next several years. I expect by the next workshop we will be able to point to increased protected areas in the prairie and continued success with species oriented work. Initiation of a departmental protected areas study and creation of the Nature Conservancy Data Centre will focus attention on gaps in the protected areas network and special ecological areas.

In addition, a growing ecological awareness by agriculturalists and keen interest to incorporate wildlife conservation into their activities provide real hope that we will continue to show real progress in meeting the overall objectives of the PCAP.

IMPLEMENTING THE PRAIRIE CONSERVATION ACTION PLAN IN ALBERTA 1989 TO 1991 - TWO YEARS OF PROGRESS

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Alberta had a unique institutional response to the challenge posed by the Prairie Conservation Action Plan (PCAP), establishing a large multi-partite Prairie Conservation Coordinating Committee (PCCC) to ensure that the goals of the plan are carried out and to encourage cooperation among the various stakeholders involved.

At the time of the second Prairie Conservation and Endangered Spaces Workshop at Regina in January 1989, I was able to inform you of the intention to create this committee, but the committee had not yet been constituted—we held our first meeting in November 1989. Since then we've met six more times over a period of slightly over two years, and there are now slightly less than two years left in the PCAP's 1989 to 1994 5-year "mandate." It is obviously an appropriate time to take stock of what we have achieved to date, to proclaim our accomplishments, to lament our shortcomings, and to look ahead to 1994 and beyond.

In the limited time available I want to focus exclusively on the PCCC and on what it has been able to do in terms of moving the prairie conservation agenda forward. This means that you're not going to get from me a snapshot of how Alberta stacks up today in terms of action toward the 10 PCAP goals. The reason, of course, is that there's lots of ongoing programs and activities being undertaken by both government and nongovernment organizations that are making significant contributions, but that are not related to the existence of the PCCC.

Most of you will not be familiar with the PCCC, so a little background information is in order. Its membership (Table 1), with representatives of all three levels of government, industry, academia, agricultural and environmental groups, regional planning commissions, and nongovernment organizations, makes this the largest committee of its kind in the country. Although initiated by the provincial government, the committee decided it would exist independently of government and established its own agenda. The purposes (Table 2) that the committee has set for itself are self-explanatory. This is the only forum in which groups exercising jurisdiction or having interests in prairie conservation issues can meet to disseminate information, share experiences, build a working relationship, and pursue coordinated responses to common challenges.

The committee also agreed at an early stage to define a list of principles that would characterize its modus operandi (Table 3). This enabled us to nail down consensus on some fundamentals as well as set a tone for the way in which the committee conducts its business.

Obviously with a committee of this kind we were very much embarking on a voyage of discovery and it may be of value to outline a number of the challenges that we face and the way in which we have tried to deal with them.

Team building is a real challenge, both because of the size of the committee and the diversity of values and viewpoints around the table. Our response has been to conduct meetings at "retreat"-like locations in rotating centres throughout prairie and parkland Alberta. This gets everyone away from the office and throws them together in a quasi-social setting. Add in field tours and a wide range of technical and dinner speakers and over a period of time we have been able to build shared experiences, break down some of the more obvious barriers between people, and both impart and exchange a great deal of information.

Running a committee of four dozen people so everyone can feel like a meaningful participant is also a challenge. By mixing plenary discussion and decision sessions with task-focused work groups and round-the-table information updates, all members are provided with good opportunities to participate.

Now at this point I can sense the skeptics amongst you say, since when was the means the end? When does the talk stop and the action begin? Information-sharing, communication, shared experiences, understanding, and bureaucrats on field trips are all wonderful

Table 1. Prairie Conservation Coordinating Committee member agencies.

Agriculture Canada
Alberta Agriculture
Alberta Association of Municipal Districts and Counties
Alberta Cattle Commission
Alberta Community Development
Alberta Energy
Alberta Environment
Alberta Fish and Game Association
Alberta Municipal Affairs
Alberta Recreation and Parks
Alberta Tourism
Alberta Wilderness Association
Battle River Regional Planning Commission
Calgary Regional Planning Commission
Canadian Forces Base Suffield, Department of National Defence
Canadian Parks and Wilderness Association
Canadian Parks Service, Environment Canada
Canadian Wildlife Service, Environment Canada
CN Rail
Coal Association
Coordination Services, Alberta Forestry, Lands and Wildlife
Ducks Unlimited
Eastern Irrigation District
Edmonton Metropolitan Regional Planning Commission
Energy Resources Conservation Board
Environment Council of Alberta
Federation of Alberta Naturalists
Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife
Land Information Services Division, Alberta Forestry, Lands and Wildlife
Natural Resources Conservation Board
Nature Conservancy of Canada

Table 1. (cont.)

Oldman River Regional Planning Commission
Palliser Regional Planning Commission
Public Lands Division, Alberta Forestry, Lands and Wildlife
Recreation Parks and Wildlife Foundation
Red Deer Regional Planning Commission
Regional Co-ordination Services, Alberta Forestry, Lands and Wildlife
Southeast Alberta Regional Planning Commission
South Peace Regional Planning Commission
Special Areas Advisory Council
Special Areas Board
Trans Alta Utilities
Unifarm
University of Calgary
Waterton Biosphere Association
Western Stockgrowers Association
Wildlife Habitat Canada
World Wildlife Fund Canada

things, but what about the acid test—what about preserving prairie? Specifically, what is happening in terms of action-oriented conservation initiatives that would not have happened without the PCCC?

This, of course, is the big challenge, and its one I'm pleased to say that we've tackled head on. Firstly, we keep the goals and action recommendations of the PCAP firmly on the agenda. Each member organization is challenged to identify, for every goal and every action recommendation, what contribution their organization is prepared to make to move the agenda forward. These "member intentions" are recorded in an overall "implementation strategy" document which is updated annually. Member organizations are encouraged to execute their "commitments" diligently and report on progress regularly. In this way the PCCC provides a stimulus to many ongoing programs and initiatives.

Secondly, when there are a lot of commitments on a particular action recommendation, where there is a high level of consensus about what might be done and where there are obvious gaps in what is currently being done, the PCCC will formally initiate a work group to work on producing concrete results. These work groups are the engine that drives the PCCC machine and in the last year we've had two come to fruition with impressive results.

WILDLIFE VALUES TRAINING

In July 1990, the PCCC established a work group comprising representatives from Alberta Agriculture, Alberta Forestry, Lands and Wildlife (Fish and Wildlife and Public Lands Divisions), and Environment Canada (Canadian Wildlife Service [CWS]). The Alberta Association of Agricultural Fieldmen was also invited to participate. The group was chaired by the PCCC's representative from the University of Calgary. The group was charged with pursuing action on the PCAP action recommendation, "Agricultural field personnel, district agriculturalists and wildlife

Table 2. Role of the Prairie Conservation Coordinating Committee.

1. The purpose of the committee is to encourage effective implementation of the PCAP in Alberta and to provide an ongoing profile for prairie and parkland conservation initiatives.

2. The committee will establish a focus and profile for the cooperative pursuit of initiatives identified in the PCAP. It will:

- serve as a forum for information exchange and cooperation between key organizations with interests in or jurisdiction over prairie conservation initiatives;

- allow key contacts to get together periodically to review the plans, projects and programs of member organizations, to assess progress and to integrate program efforts;

- constitute a cooperative partnership between different levels of government and nongovernment organizations in sharing major responsibility for implementing the PCAP, while also allowing both groups to share their experiences and strengthen mutual goals and objectives;

- encourage members to tailor their own programs, policies, or initiatives to meet the goals of the PCAP;

- review progress in implementing the PCAP in Alberta;

- identify gaps and recommend measures to fill them in such areas as inventory deficiencies or new program requirements; and

- adopt media communication strategies as appropriate to ensure that significant initiatives and accomplishments are widely communicated publicly.

3. The committee will encourage coordination and complementarity between major conservation-related initiatives such as the PCAP, the North American Waterfowl Management Plan, the Alberta Conservation Strategy, and Federal/Provincial Soil Conservation initiatives.

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biologists should receive training in the value and preservation of native habitat and all wildlife."

In response to this challenge, work group members organized a training course entitled, "Retaining Native Prairie and Wildlife Habitat in an Agricultural Landscape." The course was conducted as a block course by the University of Calgary's Faculty of Environmental Design in June 1991 at the Brooks Pheasant Hatchery with a registration cost of $175. There were about 30 registrants including habitat biologists, district agriculturalists, resource agrologists, range specialists, soil conservation specialists, and agricultural fieldmen. The course outline covered a lot of ground. Course evaluations were extremely positive and a slight profit was realized which was donated to the Antelope Creek Habitat Development Project. The PCCC intends to conduct the course again in 1992. Ultimately it is hoped that up to 200 people can take the course.

PROTECTION ISSUES, CFB SUFFIELD

The PCAP noted the existence of a large area of relatively undisturbed prairie within the Canadian Forces Base (CFB) Suffield and encouraged cooperative conservation efforts to increase protection for flora and fauna. The plan recommended that major portions of the base should enjoy significant conservation status.

The Suffield work group was established in July 1990 comprising representatives from the Alberta Wilderness Association, Alberta Forestry, Lands and Wildlife (Public Lands and Land Information Services divisions), the Canadian Parks and Wilderness Society, the Southeast Regional Planning Commission, and the Special Areas Board. The group was chaired by the Alberta Recreation and Parks representative. The

Table 3. Prairie Conservation Coordinating Committee operating principles.

The following operating principles were adopted by the PCCC at its March 1990 Medicine Hat meeting:

1. The PCCC recognizes that the goal of prairie and parkland conservation has both habitat protection and habitat development components. Explanation: While modified environments are not a substitute for irreplaceable native environments, they are indispensable if the goal of retaining biological diversity is to be achieved. The overriding interest of the PCAP is the retention of natural conservation values. In achieving this intent, the retention of existing remaining native ecosystems (protection and management) and the development of modified environments that provide natural conservation values (e.g., Ducks Unlimited projects) are complementary components of the same task.

2. The PCCC subscribes to the three international principles of the World Conservation Strategy: a) to maintain essential ecological processes and life support systems; b) to preserve genetic diversity; and c) to ensure the sustainable utilization of species and ecosystems. Explanation: Resource utilization and resource protection can both achieve nature conservation objectives. Over most of prairie and parkland Alberta the greatest potential gains can be made by placing emphasis on man conducting resource consumptive activities in a manner consistent with the retention of viable species, communities, and habitats.

3. PCCC members recognize and respect the legitimacy of different values and viewpoints. Explanation: We define a resource as a part of the environment that society values, but as a society and as individuals we value things differently. While espousing our own values, it facilitates our dealings with others if we recognized the legitimacy of other views and refrain from imposing our values as truths or imputing others as base.

4. The PCCC will focus its energies in areas where there is the greatest degree of emerging consensus and where the most progress toward realizing the goals of the PCAP can be made.

5. The PCCC will attempt to work with all stakeholders and will espouse cooperative and not confrontational approaches. The committee will pursue its objectives in a way that respects the livelihood and lifestyles of rural residents.

6. The PCCC subscribes to the principles of integrated resource management. Explanation: The work of the committee will be characterized by adopting a holistic perspective on issues, sharing information and decision-making, undertaking consultation before action, and encouraging coordination amongst stakeholders.

representatives from CFB Suffield and the CWS also played key roles.

There were a number of meetings and a field tour of CFB Suffield was conducted. The extent of the environmental stewardship exercised by the base soon became evident. The base not only has an environmental protection plan intended to ensure that military training activities do not compromise important environmental values, but also designates large areas of the base as off limits to military activity. Two, third party committees annually provide environmental advice relating to oil and gas and domestic grazing activities.

While recognizing this exemplary environmental stewardship, some members of the group continued to struggle with the issue of whether some form of designated protection was appropriate. Various options were considered, including a proposal for a federal-provincial agreement which might establish conservation lands as an ecological reserve. In September 1991, following consultations with CWS, the Department of National Defence (DND) agreed in principle to set aside a portion of the base as a National Wildlife Area (NWA). Consultations are currently underway on the details for establishing such an area. The NWA will remain part of CFB Suffield and will continue to be managed by the DND. In the event of any long-term changes in the status of the base, however, the NWA designation will ensure continued protection of these environmentally significant lands.

The protected area includes the Middle Sand Hills in the northeast section of the base and an area in the southwest corner along the South Saskatchewan River breaks. These areas are prime habitat for the Prairie Rattlesnake (*Crotalus viridus*), Pronghorn Antelope (*Antilocapra americana*), White-tailed Deer (*Odocoileus virginianus*), Mule Deer (*O. hemionus*), and a number of endangered or threatened birds including the Ferruginous Hawk (*Buteo regalis*), Burrowing Owl (*Athene cunicularia*), and Baird's Sparrow (*Ammodramus bairdii*).

Other work groups are currently active dealing with PCAP recommendations on protection issues in southeast Alberta, maintaining wildlife and habitat in municipalities, retaining urban native prairie areas, and environmental education.

There are a number of other areas where real progress has been made toward implementing PCAP goals as a result of collaboration between PCCC members. I'll provide three examples:

1. Early in 1989 a Crown land lessee in the Altario area of east-central Alberta, waving a copy of the PCAP, succeeded in forcing an Energy Resources Conservation Board (ERCB) hearing because she didn't want a well site drilled on her native prairie. In its July 1989 decision report, the ERCB allowed the well to go ahead with special conditions (the well, incidentally, was a duster, and the conditions were carried out to the satisfaction of the lessee) but also recommended that the affected agencies collaborate to develop policy guidelines aimed at affording appropriate protection for native grass prairie environments, consistent with the recommendations of the PCAP, while at the same time allowing reasonable access to oil and gas resources.

Under the coordination of the ERCB, Alberta Fish and Wildlife, Alberta Public Lands, the Land Conservation and Reclamation Council, and the Special Areas Board did just that. A draft of the guidelines was reviewed by the PCCC members and the scope of the projects was extended from just the Special Areas to the entire mixed and fescue grassland portion of Alberta. The guidelines will be issued with an ERCB information letter this month. They require the adoption of minimum impact practices and provide detailed direction to the industry for seismic, drilling production, pipeline, and reclamation activities.

2. For some time, Alberta Forestry, Lands and Wildlife in association with various regional planning commissions, has been promoting the development of Environmentally Significant Areas (ESA) inventories for rural municipalities. These inventories cover both freehold and public land and provide a reconnaissance level overview of ESAs. The relative sensitivity of sites are evaluated and classified according to their regional, provincial, and national importance. They are of considerable value to both the public and private sector for land use management and planning purposes.

The level of interest in undertaking the inventories was always variable and there were areas where no progress was being made. Creation of the PCCC created a level of expectation and peer pressure that provided momentum to "fill in" a lot of blanks. Since the PCCC was initiated, ESA inventories have been initiated or completed for the vast majority of prairie and parkland Alberta.

3. In 1990, the Municipal District of Acadia had a council policy to divest itself of its 84 quarter sections of tax recovery lands. These predominantly native grass prairie lands were to be sold for agricultural development. After hearing about the PCCC through the media, council made contact with the committee. Following initial discussions, the council expressed its willingness to consider other options. An ESAs inventory was undertaken and the council and Alberta Public Lands spent much time working on a land exchange proposal that would meet community, social, economic, and environmental objectives. At present there is agreement in principle to a proposal that would see the vast majority of 84 quarter sections retained as native grass prairie and the old sale policy has been reversed.

The examples are just vignettes, but they do demonstrate that there are a number of important areas in Alberta where applied progress is being made, that would likely not have been made without the existence of the PCAP and the PCCC.

To balance this record of accomplishments somewhat, I think its important to identify some of the impediments to progress as follows:

1. The PCCC has a rather precarious, shoestring existence. No new monies were provided to run the committee and the members themselves fund their own activities. The PCCC does not have staff, library, or research funding capabilities and it is only within the last month that we have managed to get some basic financing arrangements in place to allow for the

costs of holding the meetings and publishing an annual report.

2. Not everyone is wildly enthusiastic about prairie conservation initiatives and the PCCC is a very broadly representative committee. Because the committee operates by consensus, and because it adheres to its operating principles, the committee has not been as progressive or as activist as many members would like it to be. At the same time of course, we have avoided alienating any stakeholders and the initiatives that the committee has pursued have broad societal support.

3. These days everyone is doing more with less and usually more and more with less and less. This strains our ability to resource the activities of the committee effectively and to ensure that the projects we do take on are completed quickly. The list of things that we could be doing is intimidating, but if we over-program our members we run the risk of starting more, but finishing less. To date we've successfully maintained a high level of interest and participation with about three-quarters of the total membership participating actively in every meeting.

I'd like to conclude with a few observations about what is likely to be accomplished over the next couple of years, where we are likely to be standing with regard to the goals of the PCAP, and what might come next.

I expect slow but steady progress from the PCCC. The number of dramatic announcements (e.g., Suffield), is likely to be limited, but the committee will continue to make valuable contributions where needed actions "fall between the cracks" of existing jurisdictions, programs, and initiatives. The committee will more systematically track the implementation of members' commitments, and this, together with the adoption of appropriate communication strategies and special events (such as the Duke of Edinburgh's visit in his capacity as International President of the World Wildlife Fund for Nature) will help to maintain a momentum and profile for prairie conservation initiatives at a time when the political will and financial ability of governments to provide environmental leadership is becoming more limited. The networking linkages between member organizations will likely continue to provide a catalyst for various cooperative conservation initiatives.

By the end of 1994 I anticipate we will have seen significant progress toward the accomplishment of many of the PCAP's goals but we will be a long way from home. I think it will also be evident at that time that there are some areas where we are not making any real progress and others, overlooked by the PCAP, where we are. This likely adds up to a need to document what has been achieved, refine the strategy, and launch a revised prairie conservation campaign. This iterative approach is time consuming, but necessary, if we are to continue to remain relevant and effective. One thing is for sure—we won't be able to rest on our laurels.

SASKATCHEWAN WILDLIFE HABITAT STATISTICS (1976 TO 1990)

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BACKGROUND

This paper summarizes several habitat loss findings encountered while reviewing various habitat projects and proposals generated by Wildlife Branch, Saskatchewan Natural Resources (former Saskatchewan Parks and Renewable Resources), between 1984 and 1990.

A limited amount of information is available on Saskatchewan's wildlife habitat base. This presents a significant problem for wildlife managers. The Terrestrial Wildlife Habitat Inventory (TWHI), conducted in Saskatchewan between 1975 and 1983, still provides the best information on how much "critical" wildlife habitat exists and where it is located. However, significant habitat loss has occurred in many areas of the province since this inventory was conducted. Habitat loss has resulted in an ever-decreasing supply of prairie wildlife, and is the major cause of wildlife species becoming threatened or endangered.

ASSUMPTIONS

For the purpose of this report, native vegetation lands, native lands, and unimproved lands are assumed to provide wildlife habitat. The percent, or amount, of land remaining in a native vegetation condition is assumed to reflect the amount of remaining wildlife habitat, as indicated in the following nine sources or studies.

RESULTS

In March, 1988 a startling example of habitat loss came to light during preparation of a (Fish) and Wildlife Development Fund Proposal: "Conservation of White-tailed Deer Winter Habitat in Southeastern Saskatchewan" (Wildlife Management Zones [WMZ] 16, 31, 32, and 34) (Weins 1988). Examination of 1979 to 1980 Saskatchewan Property Management Corporation photomaps revealed that only 8,100 acres, or 1.17% of WMZ 32 remained in White-tailed Deer (*Odocoileus virginianus*) winter habitat, (land parcels dominated by native Aspen [*Populus tremuloides*] cover, 40 acres and larger, Appendix 1). Habitat objectives calculated for this WMZ (Zone Area = 689,000 acres) indicate that about 32,000 acres of White-tailed Deer winter habitat are needed to sustain desired deer populations for consumptive and non-consumptive use. I speculate that the amount of remaining winter habitat is a limiting factor to White-tailed Deer population growth in WMZ 32.

The booklet "Lets leave some Wild in the West - Prospectus For A Prairie Conservation Action Plan" (World Wildlife Fund 1987) states that, "a 1978-82 census showed that the areas of our five types of natural prairie had been markedly reduced in size." Only 18% of the shortgrass prairie, 24% of the mixed grass prairie, and 25% of the aspen parkland areas remain in a native condition. Areas not already cultivated may have been damaged owing to the demands placed on the land by continuous grazing, especially during the drought years of the 1980s. In Alberta only 22% of the fescue prairie remains, while in Manitoba less than 2% of the tall grass prairie persists. Present wildlife populations are relying for survival on less than one quarter of their former native landscape.

Sugden and Beyersbergen (1984) looked at 101 quarter sections of aspen parkland in east-central Saskatchewan and found that, excluding wetlands, 82.7% of the entire area was cultivated annually. Of 156 public road allowances examined, two-thirds were partly or entirely used for private farming practices.

According to the 1986 Statistics Canada Census land use data for Saskatchewan (Appendix 2), 49.53 million of 65.73 million acres (75.4%) reported by farmers have been improved (assumed cultivated). Of the 16.2 million acres reported as unimproved (assumed wildlife habitat), 13.34 million are rated as unimproved pasture; 0.38 million are reported as woodlands, and 2.48 million are reported in the "other unimproved" category (areas of native pasture, brush pasture, grazing or wasteland, sloughs, marshy, and rocky land). Comparing the 1986 figures to former Statistics Canada figures yields information on the decreasing wildlife habitat base (Table 1).

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Table 1. Increases in improved land - 1951 to 1986 (Statistics Canada).

	% of Land Reported as Improved	% of Land Reported as Unimproved	
Census Year	Cultivated	Woodland	Other Unimproved
1951	62.9	4.8	32.3
1961	66.9	3.4	29.7
1971	71.4	1.5	27.1
1981	75.9	1.1	23.0
1986	75.4	0.6	24.0

Although the reported percentage of cultivated land between 1981 and 1986 stabilized at approximately 75%, the static nature can be attributed to the different total and improved acreages reported by farmers in the two census years. In 1981, 67,318 farmers reported 48,639,871 acres as improved whereas in 1986, 63,431 farmers reported 49,530,723 acres as improved. This increase in improved land (890,852 acres), divided by the reported unimproved acres (15,476,808) remaining in 1981, yields a habitat loss figure of 5.76% from 1981 to 1986, or 1.15% per year (Appendix 13). This 1.15% loss per year compares with a 1.23% loss per year calculated from Saskatchewan Municipal Assessment data (1976-1985).

The 1986 Statistics Canada data on land use was also used to calculate 1981 to 1986 habitat loss figures for five grassland 1:250,000 map sheets: Willow Bunch Lake (10.56%), Wood Mountain (5.93%), Cypress (8.06%), Prelate (4.36%), and Swift Current (12.72%) (Appendix 14). Overall grassland habitat loss indicated was 7.88% from 1981 to 1986 or 1.57% annually.

Milliken (1980) studied habitat loss on a 407 mi^2 block in southwestern Manitoba from 1971 to 1979. He reported a 19% reduction (4,938 acres) in White-tailed Deer winter range from 1971 to 1979. Overall reduction in native vegetation (summer and winter range) equalled 17% (15,418 acres). Habitat loss on private land, vulnerable to clearing, amounted to 22% over the eight years. Nine percent of the municipal rights-of-way had been bulldozed and 3,320 wetlands were lost to bulldozing, cultivation, or drainage during the eight years. Crown lands in the study area accounted for 12.6% of the deer winter range, but supported 28.2% of the wintering deer herd.

A 1981 study conducted in Saskatchewan by Stewart and Longmuir (Wildlife Population Management Bulletin 82-3 Appendix 3) (Stewart 1982) reviewed 1977 to 1981 habitat loss in the Weyburn, Melville, and Yorkton NTS 1:250,000 map sheet areas. Of 13,880 acres examined on the Weyburn map area, 2,280 acres or 16.4% had been cleared in four years. On the Melville and Yorkton map areas 9,840 of 44,480 acres (22.1%) had been brushed. On 6,400 acres of Crown land, 320 acres (5%) had been cleared whereas 1,800 of 6,800 private acres (26.5%) had been bulldozed. Annual habitat loss occurred at a rate of 4.1%. On Crown land the annual loss was 1.25%, while on private land the loss was 6.6% annually from 1977 to 1981.

A 1986 study conducted in southeast Saskatchewan (Rural Municipality [RM] of Antler, No. 61) by the Prairie Pothole Project coordinator, R.D. Russell, estimated that 44,300 acres of native habitat existed in 1986 (based on 19,968 non-cultivated pond acres and 24,336 non-cultivated upland acres) (Russell 1986 Appendix 4). This figure compares well with three other independent estimates of remaining wildlife habitat in this area:

1. Statistics Canada (1987) data for 1986 indicates that 202 farms in the RM of Antler No. 61 reported 45,147 (22.18%) unimproved acres. Surprisingly only 484 acres (1.07% of the unimproved area) were reported as woodland. This represents only 0.24% of the total RM area.

2. Based on Stelfox's (1979) TWHI estimate, there was 28% native habitat in the Redvers-Maryfield-Kelso area in 1977 and 0.9% annual habitat loss. Russell (1986) projected these figures to yield a second estimate of 50,709 acres in native vegetation.

3. Based on evaluation of the 1986 Statistics Canada data for the Carlyle-Redvers-Maryfield area, the rate of habitat loss was 1.6% per year (Statistics Canada 1987). Projecting this rate through to 1986, Russell (1986) calculated another estimate of 46,779 acres remaining native.

Municipal Assessment Authority Data 1976 to 1985

Cultivated acreage data obtained from the Saskatchewan Assessment Management Agency (former Saskatchewan Municipal Assessment Authority; Appendix 5) was used to calculate Saskatchewan habitat loss from 1976 to 1985. Twenty-five rural municipalities exhibited habitat loss greater than 30% over these 10 years. I assumed the assessment data was applicable to loss of upland native vegetation since the figures were generated from increases in cultivated acres, 1976 to 1985. Table 2 gives selected habitat loss figures for 17 of these 25 RMs and Table 3 summarizes this Saskatchewan Municipal Assessment Authority data.

Assuming 25,287,932 acres of native vegetation (wildlife habitat) existed in 1976 and a loss of 3.1 million acres up to 1985, this yields a provincial loss of 12.32% over the 10 years. Appendices 6, 7, and 8 show corresponding 10 year habitat loss figures of 15.1% in the forest fringe; 5.9% in the grasslands; and 13.5% in the southeast parklands. Appendix 9 illustrates the top eight ranking RMs in terms of habitat loss (1976 to 1985). Appendix 10 gives the rate of loss for seven selected Member Legislative Assembly constituencies using the Saskatchewan Assessment Management Agency figures.

Table 2. Rate of habitat loss for selected rural municipalities in Saskatchewan 1976 to 1985 (Saskatchewan Assessment Management Agency).

RM	Total acres in RM	Cultivated acres prior to 1976	Acres assumed native in 1976	Cultivated acres by 1985	% of RM cultivated by 1985	% loss in native acres 1976-85
45	207,030	152,125	54,905	177,768	85.9	-46.7
211	234,520	126,737	107,783	174,318	74.3	-44.1
219	252,530	179,684	72,846	207,684	82.2	-38.4
241	198,820	91,200	107,620	127,013	63.9	-33.3
243	206,130	132,203	73,927	161,341	78.3	-39.4
247	213,290	126,914	86,376	158,053	74.1	-36.1
286	181,270	149,704	31,566	163,963	90.5	-45.2
321	137,440	69,607	67,833	110,335	80.3	-60.0
336	245,236	156,212	89,024	196,649	80.2	-45.4
339	206,270	167,689	38,581	183,420	88.9	-40.8
344	523,130	166,291	356,839	370,966	70.9	-57.4
403	228,360	171,455	56,905	192,265	84.2	-36.6
428	203,720	152,100	51,260	170,354	83.6	-35.4
429	208,590	149,211	59,379	170,287	81.6	-35.5
456	155,490	113,418	42,072	130,368	83.8	-40.3
487	207,050	137,792	69,258	160,177	77.4	-32.3
490	130,790	87,792	42,998	104,244	79.7	-38.3

Table 3. Summary of native vegetation loss in Saskatchewan 1976 to 1985 (Saskatchewan Assessment Management Agency).

All RM Acreage	Cultivated Acres Prior to 1976	Cultivated Acres Reported in 1985	Increase in Cultivated Acres 1976-85
67,754,362	42,466,430	45,582,285	3,115,855

(Fish and) Wildlife Development Fund (FWDF) Saskatchewan Natural Resources (SNR) habitat purchase effort in southeast Saskatchewan 1989 to 1990

In July 1989, SNR hired a land negotiator to work in southeast Saskatchewan in an attempt to implement phase one of the southeast deer proposal. The proposal indicated there were 33 habitat parcels larger than 40 acres in WMZ 32, totalling 4,740 acres which landowners might be willing to sell to the FWDF. In WMZ 34, habitat was divided into two priority areas for possible purchase. The priority one area held 99 land parcels containing 13,470 acres of vulnerable winter habitat. Priority two area vulnerable habitat totalled 44,705 acres in 161 separate parcels. Between July 1989 and September 1990 the land negotiator inspected 139 priority land parcels: six in WMZ 31, 30 in WMZ 32, and 103 parcels in WMZ 34 (Appendix 11).

Review of 1979 aerial photomaps for these 139 parcels indicated 15,820 acres of native wooded habitat. Land inspections and interviews with landowners in 1989 and 1990 indicated that only 9,667 acres remained wooded and that 6,155 acres had been cleared and/or cultivated. Net habitat loss for the 1980 to 1990 period is 38.9% or, 3.9% annual reduction in deer winter habitat.

SUMMARY

There are about 67 million acres in agricultural Saskatchewan, south of the provincial forest. By 1986, 75.4% of this landscape had been modified leaving 16,198,000 acres (24.6%) of "unimproved" land to provide wildlife habitat. Only 377,000 acres or 0.6% of the native landscape remained in woodland in 1986.

The TWHI conducted from 1975 to 1983 indicated there were 3.44 million acres of provincial Crown "critical" habitat (Appendix 12) representing, in 1983, one-third (33%) of the total "critical" habitat in agricultural Saskatchewan. Total "critical" habitat estimated in 1983 was 10.4 million acres.

If habitat loss has remained constant to 1992 one can assume provincial losses of native lands to be at least 1.15% per year. Applying this 1.15% rate of loss from 1986 to 1991 yields 15,287,500 acres remaining native and supplying wildlife habitat in 1992.

The most recent habitat loss figures for parkland Saskatchewan (southeast FWDF effort) indicate 38.9% woodland loss from 1980 to 1990.

Knowledge of the amount and distribution of remaining wildlife habitat will help target habitat retention and enhancement programs in landscapes where the greatest benefits to wildlife can be expected.

Continued wildlife habitat loss in Canada's prairies will result in more endangered wildlife species and threaten our prairie biodiversity.

Note: Copies of Appendices 1 through 14 are available from Wildlife Branch, Saskatchewan Natural Resources, 3211 Albert Street, Regina, Saskatchewan S4S 5W6 or from the author.

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USE OF REMOTE SENSING IN THE MAPPING OF HABITAT ON THE CANADIAN PRAIRIES

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INTRODUCTION

The prairies, including Saskatchewan, are experiencing significant changes in agriculture and the resource industries. At the same time, we are required to do more with less in our approach to resource management. Computer technologies are beginning to play major roles in this management. One of the most significant is the use of Geographic Information Systems (GIS) technology to store, analyze, and manipulate geographical and tabular data.

One additional technology that offers considerable promise to resource planners is remotely sensed images and, in particular, satellite imagery and the accompanying technologies of visual and digital analysis.

This paper briefly looks at types of satellite data available, discusses the forms in which it is commonly used, and explores the weaknesses and strengths of the technology for future resource planning.

REMOTE SENSING

What is Remote Sensing?

Remote sensing is the science of viewing something from afar. In other words, it is ability to study an object without coming in direct physical contact with it.

Remote sensing, when it involves satellites, deals with the collection of reflectance information from the earth by sensors on board specific satellites, and the transmission of the information in digital form back to earth. Both digital and manual interpretation of data are then used to describe some characteristics of the earth's surface such as: land cover, fault line locations (geology), ice structure (Arctic shipping), etc.

Types of Satellite Data Available

Numerous satellites are presently orbiting the earth. However, data from four general sources are likely to be used in the future. The two most commonly used data sources are derived from satellites which presently orbit the earth in a near polar path approximately 650 kilometres above the earth's surface. The American LANDSAT series, return to the same area on a 16 day repeat cycle. Cloud cover plays a major role in determining how often you are able to get useable image data for a particular region.

The SPOT satellite, launched within the last two years has a 26 day repeat cycle, but has the added advantage of a reflecting mirror which can "look back" at areas that were covered in cloud during previous orbits. This satellite, therefore, has the capabilities of imaging the same area potentially 14 days out of 26.

Another satellite group, National Oceanic and Atmospheric Administration, provides broad coverage of the earth with a 12 hour repeat cycle. Data from these satellites are commonly seen during television weather reporting and are presently used for mapping or monitoring large regional areas (e.g., drought monitoring).

A fourth group, dealing with the collection of radar data, includes an EOSAT recently launched by the European Space Agency and Canada's RADARSAT which is to be launched in 1994. Radar data has the advantage that it can "see" through cloud. It has its own specific problems and lacks the reflectance gathering capabilities of the previous mentioned sensors. It will likely find its use in land cover mapping in combination with other sensor data.

Data Reception and Description

The data is sent to earth in digital or numeric form. A receiving station just outside Prince Albert, Saskatchewan is the site for the collection of image data for most of Canada, the northern states, and Alaska for both the LANDSAT and SPOT satellites. A second receiving station has been built, in the last few years, in eastern Canada at Point Claire, Québec.

All satellite data purchases for Canada are channelled through RADARSAT International, recently established in new headquarters in Richmond, British Columbia.

Sensors on board the satellites acquire reflectance information from the earth in a grid format. Each grid cell is called a pixel or picture element. It is the size of these pixels that determines the "resolution" of the satellite. For example, sensors on board the LANDSAT 4 and 5 satellites include: the Multi-Spectral Scanner (MSS) sensor with its 58 x 79 metre pixels and the Thematic Mapper (TM) sensor which acquires 30 x 30 metre pixel data.

The French SPOT satellite is capable of imaging the earth's surface reflectance in 10 metre single channel Panchromatic (black and white), as well as simultaneously acquiring data in a 20 metre Multi-spectral data (colour) format.

Data is purchased in the form of computer compatible tapes or hard copy prints or transparencies. The image area is described as a scene or one quarter (quadrant) of a scene. A single scene of TM or MSS data covers an 185 x 185 kilometre area while SPOT images cover an area about 1/6 as large.

Although the spatial resolution of SPOT is superior to TM data, it has poorer "spectral" resolution. The six versus four channels of reflectance information, acquired by the TM sensor, tends to have better capabilities when it comes to separating different vegetation cover types.

This attempt to separate or classify different cover types on the ground is one of the major uses of satellite data and is the use I will discuss in this paper.

The Vegetation Classification Process

Canada is a world leader in the development of computer software suitable for the analysis of satellite, or in fact, any digital image data. The two systems most commonly used are the ARIES series sold by the DIPIX company in Ottawa and the PCI software sold by the company of the same name, also with head office in Ottawa.

Both software systems offer algorithms which are capable of image enhancement and image classification. The classification process, in simplified terms, involves "training" the computer to recognize and tag pixel areas with similar reflectance values. This is accomplished by outlining the location, on the image, of known areas of particular cover types. These are referred to as "training areas." The software program then searches the image for similar reflectances. Each reflectance grouping is called a theme, or class, and corresponds to a cover type chosen by the systems operator.

The final products of a classification can be colour hard copy maps, transparencies, or computer "thematic" files suitable for transfer into a GIS system. It is this latter possibility that is arousing considerable interest in recent times.

In addition to the digital analysis of the data, it can also be interpreted manually in a similar manner to air photos. SPOT even has some stereo viewing capabilities.

The fact that the data is digital, provides some significant advantages. Subsequent information in the form of additional scenes of data, past or future, can be "corrected" in such a manner that they are aligned with existing data. Investigations such as "change detection" can then be done in an operational sense.

Change detection is a process where multiple images are obtained for the same area. Either previous conditions are studied and compared to present conditions, or future imagery is purchased periodically to monitor changes that are occurring over time. An obvious example would be the monitoring of the loss of native grassland areas. Reliable data from the LANDSAT satellites is generally available from about 1975, although the first LANDSAT satellite with a MSS sensor on board began to send data back to earth in 1972.

As you might expect from discussions about change detection, it is also relatively easy in a mechanical sense to call up data then refine and extend a classification that has been generated through digital means. In addition, companies in the business of developing and supplying software and hardware packages to the remote sensing community have developed relatively good operational colour plotting capabilities.

It is interesting to note that this has not been the case with the GIS technology which tends to have relatively poor mapping capabilities. One means of alleviating this problem is the use of computer links, not only to transfer remotely sensed data and its digital products to GIS, but now to transfer GIS data directly to plotters developed for use with image analysis systems.

The ability to quickly and relatively cheaply produce colour maps is a very significant requirement where digital data is to be used in a management role. Previous to the development of these technologies, most mapping and virtually all colour mapping was duplicated by lithographic means. Minimum runs of 1000 or more copies were required for any feasible economies of scale. Set up and printing were both labour intensive and very time consuming, resulting in few updates and therefore, outdated maps.

The new technologies have resulted in virtually real time map development and printing, and although the per map charge is relatively high ($20-$85/map), the actual investment is low, as limited runs of maps are feasible. Frequent updates are both feasible and relatively easily accomplished simply by making the necessary changes in the digital file and re-printing the map. Scale is also of less importance and most plotting software and hardware have a "dial your own scale" approach to handling scaling demands.

With these glowing capabilities why is satellite data not used extensively in resource management today?

There are a number of reasons for our slowness to adopt the use of satellite data in an operational sense. The data is initially expensive and in order to realize its full potential, digital analysis, via the specialized computer software, is required. Analytical systems are expensive to purchase or to obtain the services of private systems and operators. The software programs are complex and extensive and require a considerable "learning curve."

Satellite data is relatively new technology. In the 1970s when it was first available, it was over-sold and made many resource managers "gun shy" about its use. Because the data represents a substantial investment, it is often difficult to justify. Since, at least in its initial use, it often does not replace an existing method of management, but rather acts as a supplemental data set. The use of remotely sensed data in the form of satellite imagery, requires GIS technology as an additional tool to really become attractive.

Why Then Use Satellite Data?

Although the data appears expensive at the time of purchase, it covers large areas (in comparison to air photos) and can usually be obtained in an up-to-date form. Digital classification provides perhaps the only means of mapping large regional areas in a practical time frame. Traditional mapping that would take years to complete, and would often be outdated before completion, can be done in much shorter periods of time with the aid of satellite data and digital analytical techniques.

To put things into proper operational perspective, the following example can be used. Vegetation cover mapping of the entire forested, or conversely, cultivated region of Saskatchewan could be completed in a little over one year with the aid of satellite data. This would require many years to complete using traditional air photo techniques. As might be expected the cost of the former method would also be significantly lower.

The mapping "capability" of the satellite data is admittedly coarser than that which is capable by air photo interpretation. However, this must be weighed against cost, time constraints, and any updating programs that may be envisioned. The requirement for updated information should be weighed against the need for more detail when reviewing management needs. Extreme detail is often less important than the availability of recent inventory data. A more detailed look can often be restricted to specific regional areas, when it is required for additional management decisions.

The worst case scenario occurs when resource managers, waiting for the perfect data set which has both an unrealistic and unattainable price and unworkable time frames, end up with little information to assist them with their management concerns. Questions that should therefore be asked are: what are my objectives?; what level of detail is required?; what is my budget?; what is my time frame?; and last, what are my future plans for the program and how should I design, run, and update this program?

The problem concerning "too much detail" will soon become very apparent as managers begin to use GIS technologies for both the storage and analysis of resource data. A small increase in the data base size is reflected in a large increase in the size of the computer files; the increase generally being geometric in its effect. Very quickly, managers will have to pick and choose what portions, what data bases, and what resolutions they really require for their particular problem.

For their particular problem, here, possibly, lies the answer to some of the problems inherent in the use of satellite data. Is it necessary to purchase data specifically for one group's problem, or is it perhaps better and more feasible to participate in joint purchases with other users? The question is, in fact, rhetorical and it is indeed possible, feasible, and in fact, very desirable to "share" data and data processing with other users. The problem of relatively high up-front cost, although not disappearing altogether, certainly takes on a low profile when this is done.

Many resource managers have surprisingly similar aims, or, at least, work with the same or similar data sets. This is really not all that surprising when you look at an ecosystem approach; if you pluck one strand of the spider web (ecosystem) the rest of the web begins to vibrate, signifying that the strings (ecosystem components) are all attached and affected by changes to each other.

A forest fuels map used by forest managers in northern Saskatchewan has many of the components of a wildlife habitat map, or a land use map similar to that which those involved in tourism planning might require. In the south, an existing vegetation cover map is useful to the wildlife manager, but equally useful to those who are attempting to assess and prevent soil erosion on the prairies. Day-to-day management problems faced by people, such as crop insurance, also find uses for the cover data in their development of programs which provide fair assessment of insured losses of crops, forage, and pastures in a timely and economic manner. Those involved in the fight for endangered species or habitats may well have interest in only some components (classes) of a vegetation classification.

A satellite data set is also of interest to totally unrelated groups such as power authorities, mining, and petroleum industries which must make educated decisions on future development; decisions that hopefully (and the hope is theirs as well as the conservationist) avoid or reduce environment impacts. Avoidance spells savings for all groups concerned.

Digital forms of databases therefore, allow us to modify, select, and use portions of, or all of a data base. They allow us to incorporate the information readily in computer systems such as a GIS. Associated technologies provide us with the abilities to produce up-to-date maps, photographic products, and tabular files (such as area calculations). They are one of the tools of the future to assist us in making fewer mistakes, through educated decisions. They represent a means of applying regional concerns to management policy on a provincial, as well as national scale. The challenge for the future is to find economical means of accessing and using the data for the betterment of mankind and the world around us.

LAND COVER CHANGE IN THE ANTLER MUNICIPALITY, SASKATCHEWAN 1986 TO 1990

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In 1986, Saskatchewan Natural Resources (SNR) (1987) selected the Rural Municipality (RM) of Antler as the site of the Prairie Pothole Project to conduct a pilot study of the effectiveness of various landowner incentive programs to retain or enhance waterfowl nesting habitat. These measures were implemented to counter land use impacts in a region identified as a high capability waterfowl producing area (Stoudt 1971), but where the integrity and quality of waterfowl habitat is threatened by ensuing land use trends. The goals of this habitat restoration project were to encourage the preservation of native vegetation along with wetlands and to restore nesting cover to foster improvements in waterfowl recruitment by encouraging increased homing and nesting success. In conjunction with the habitat restoration program, SNR and the Canadian Wildlife Service (CWS) implemented an evaluation program to monitor habitat trends and responses of waterfowl populations to natural and manmade habitat changes in the experimental area (RM of Antler), compared to an untreated control area (RM of Walpole and Maryfield). This study provided an opportunity to monitor, during the course of a drought (1987 to 1990), land cover change related to land use over an extensive area.

A quantitative baseline inventory of the spatial amount and distribution of remaining native and improved perennial vegetation cover, including the extent of existing wetlands, are prerequisites to monitoring land cover change as modified by weather patterns and land use. The objectives of this study are: 1) to collect baseline habitat data from sampling sites, comparing land cover distribution as measured from linear transects and 65 ha sample plots; 2) to monitor land cover change (1987 to 1990) and compare trends between the experimental area and the neighbouring control area; 3) to estimate the amount of perennial vegetation cover in the Antler municipality and relate it to the amount of improved and protected vegetation cover influenced by the habitat restoration program.

STUDY AREAS

The Antler municipality comprises 808 km^2 (312 mi^2), compared to the control area which comprises 311 km^2 (120 mi^2). The study areas are located on hummocky low-relief moraine which is intersected by several south-trending, gravely outwash channels containing intermittent streams such as Antler River and Gainsborough Creek. Wetlands are dominant features of the landscape as expressed in densities of about 85/km^2. Developed upon medium textured and calcareous glacial till or fluvial sediments, the Oxbow loam to sandy loam soils (Anderson and Ellis 1978) are highly arable and productive, being suitable to annual cereal and oilseed crops with scattered forage and pasture lands. According to the 1986 Census of Agriculture (Statistics Canada 1987), the total area of improved land comprised about 64,088 ha or 78% of the available farmland in the municipality. Another sampling survey estimated annual cropland at 75%, forage land at 4.5%, and grazing land at 6.5% of the municipality (Millar 1988). Approximately 2850 ha of unimproved Crown land, including critical wildlife habitat lands, also occur. These lands, as well as grazed pastures, are situated along stream channels and contain some of the last remaining large blocks of aspen parkland habitat.

SURVEY METHODS

An extensive habitat monitoring system was designed to assess changes in land cover over the experimental and control areas. The study areas were stratified into representative landscapes onto thematic mapper imagery (Ducks Unlimited [DU]) to depict gradients in wetland densities and percent of land cultivated. The experimental area was divided into 11 landscape areas and the control area into five landscapes; each landscape was sampled by one transect, 12.8 km by 0.4 km, for a total area of 5.2 km^2. The combined transects sampled 83 km^2, or 7% of the study areas (Figure 1). Within each landscape, the transect was positioned on useable roads to facilitate travel and to conform to techniques adopted for air-ground census of waterfowl and habitat assessments [United States Fish and Wildlife Service (USFWS) and CWS, 1987]. Joint crews from SNR and CWS conducted waterfowl counts and assessed land use impacts to wetlands on each transect.

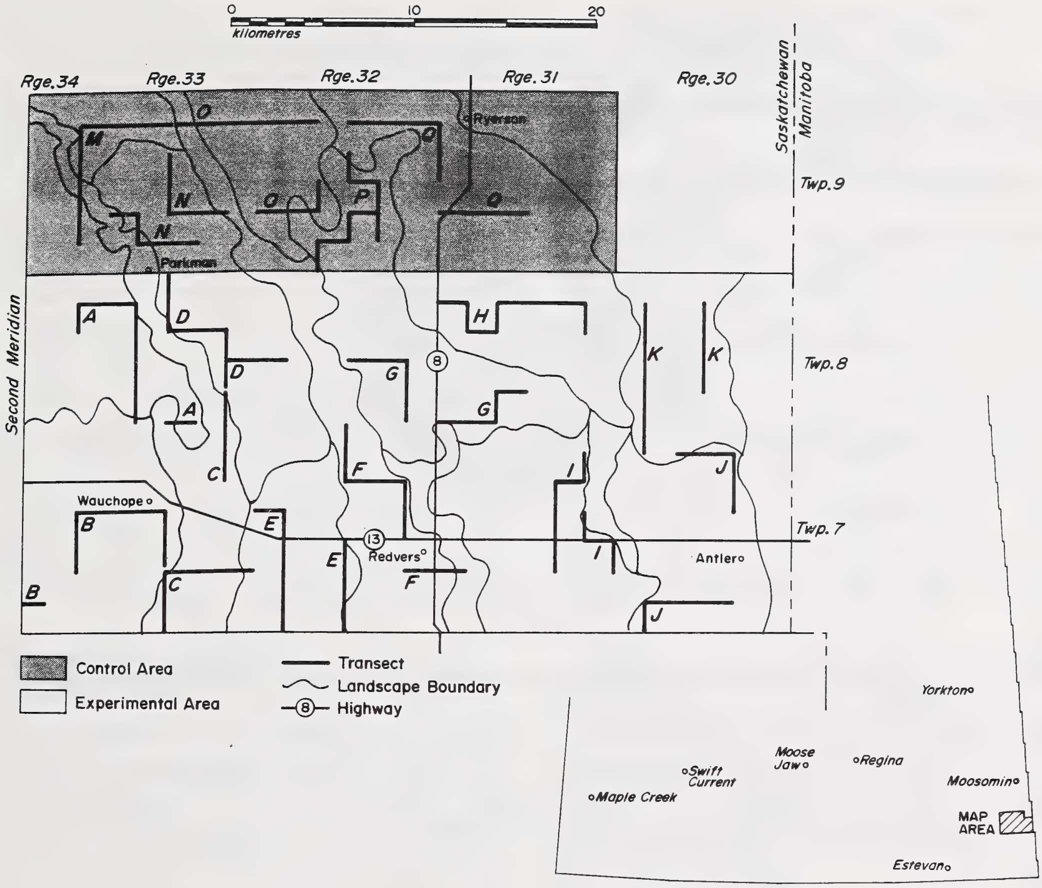

Figure 1. Location of Prairie Pothole Project showing control and experimental areas and transects.

In July 1986, DU furnished complete aerial photographic coverage (colour infrared film), at a scale of 1:20,000, of the experimental and control areas. Enlarged black and white prints (1:10,000), reproduced from mylar transparencies, were used as field maps to assess habitat conditions and to ground-truth 25% of the sampled area. Subsequently, cover maps (1:6,000) were prepared of the 16 transects from the original aerial photographs using the Procom 2 map transfer projections. Using photo-interpretation, CWS mapped, scaled, classified, and digitized polygons on each transect segment (1.6 km) to a minimum size of .01 ha. Cover maps were verified by field checks in July and September, 1987, and maps were corrected and updated. Polygons were coded into categories of cover classes such as wetland, woodland, grassland, disturbed land, annual crops, forage, farm sites, industrial sites, denuded areas, excavated areas, and rights-of-way. These procedures were repeated in 1990, with the acquisition of 1:6,000 colour infrared photography of the transects, except that photographic mylars were used as base maps. Digitized information on cover classes was entered and stored in computer databases. The two databases were processed, and registered, and changes in areas of cover classes were computed.

In 1987 an additional mapping survey of land cover was undertaken in the Antler municipality of 24 sample quarter section (65 ha) plots, distributed along a 19 km flightline segment. Cover maps prepared from interpreted 1986 aerial photographs, were classified, coded, and digitized and the plots were surveyed to develop baseline habitat data for the Prairie Habitat Monitoring Project (Millar 1988). This project is part of a prairie-wide monitoring network associated with USFWS air-ground waterfowl survey transects.

1987 COMPOSITION OF LAND COVER CLASSES

Comparison Of Survey Methods

Independent survey estimates, of the distribution of cover classes on uplands, were compared between the Prairie Pothole and the Prairie Monitoring studies (Table 1). The two studies surveyed approximately 7% and 2% of the municipality area respectively, yet the results of grouped classes are very similar. The percent cover of native grass may be inflated somewhat by additions of grassy wetland margins, which usually have mixtures of introduced species such as Awnless Brome (*Bromus inermis*), Quack Grass (*Agropyron repens*), Crested Wheat Grass (*A. cristatum*), and Kentucky Bluegrass (*Poa pratensis*). Upland native grasses include Bluejoint Wheat Grass (*Agropyron smithii*), Slender Wheat Grass (*A. trachycaulum*), Tufted Hair Grass (*Agrostis scabra*), Canada Bluegrass (*Poa compressa*), and less common species such as Green Needle Grass (*Stipa viridula*), Blue Grama (*Bouteloua gracilis*), and Little Bluestem (*Andropogon scoparius*). Right-of-way grasses were grouped with the introduced, or tame grasses.

According to both surveys, total grassland occupies about 19% of the available upland area (excluding wetlands) (Table 1). The Prairie Pothole Study indicates a slightly higher percentage of woodland, due to the more widely dispersed samples that may intersect more wooded stream reaches than the quarter section plots. Wetlands which numbered more than 4800 on the transects, comprised 14.5% of the sampled area, compared to 16.7% of the sampled plot areas in the monitoring study (Millar 1988). Both surveys produced almost identical estimates (75%) of the proportion of upland cultivated. Agriculture census data, unadjusted for wetlands, indicate that 78% of the total farmed area was improved in 1986 (Statistics Canada 1987).

Table 1. Independent survey estimates of distribution of upland cover classes, Antler municipality, 1986 to 1987.

	Prairie pothole study		Prairie habitat monitoring[1]	
Class	Area (ha)	Upland area (%)	Area (ha)	Upland area (%)
Native Grass[2]	515	10.6	138	10.4
Tame Grass[3]	416	8.5	114	8.6
Woodland	234	4.8	52	3.9
Other[4]	74	1.5	27	2.0
Cultivated	3,634	74.5	993	75.0
Unimproved[5]	783	16.1	200	15.1
Total Upland	4,873		1,324	
Total Wetland	825		266	
Area Sampled	5,698		1,590	

[1] Prairie habitat monitoring results adapted from Millar (1988).

[2] Native grass includes native upland and wetland margin grasses.

[3] Tame grass includes seeded or introduced upland grasses and right-of-way grasses

[4] Other includes brush cover and developed sites.

[5] Unimproved includes all native vegetation less wetlands.

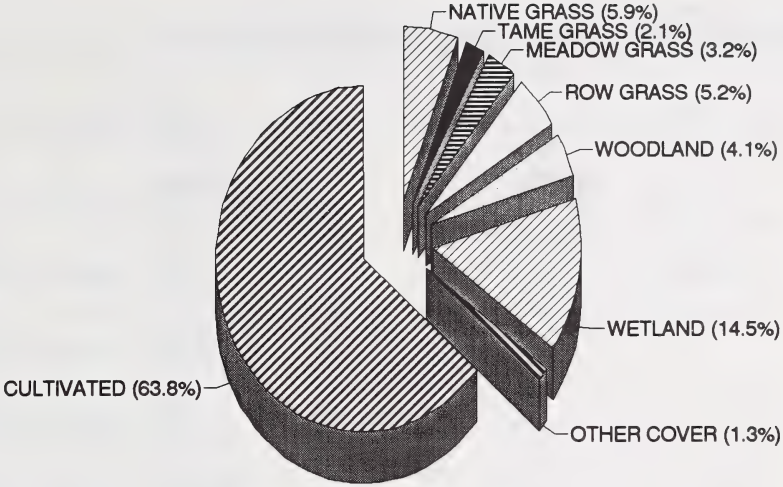

Figure 2. Composition of land cover classes in Antler Municipality, 1987.

Baseline Land Cover Distribution

In the experimental area (1987), total hectares of grassland excluding rights-of-way was 635.4, representing 11.2% of the landscape. In the control area, grassland occupied 424 ha, or 16.4% of the landscape (Figure 2 and 3). The control area contains higher proportions of native, tame, and margin grass. These differences between areas are reflected in relatively more units of pasture land sampled in the control area.

Woodland which includes shelterbelts, but excludes tall shrubs or brush, comprises 4.1% of the experimental area and 7.1% of the control area (Figure 2 and 3). These area differences in the amount of woodland were not significantly different ($p > 0.1$). This represents total wooded areas of 234 ha and 183 ha respectively, as proportionately more transect segments containing larger blocks of woodland (> 4 ha) were found on the control area in association with pasture or idled land.

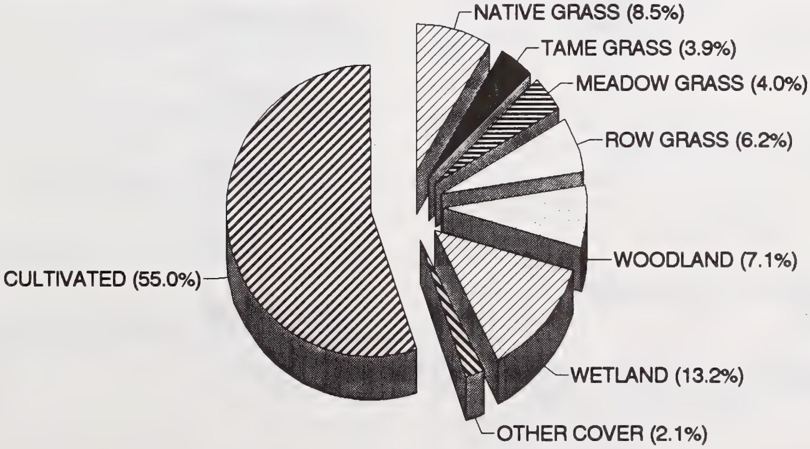

Figure 3. Composition of land cover classes in Walpole and Maryfield Municipalities, 1987.

Table 2. Changes in diversity of cover class units, 1987 to 1990.

		Mean cover patch size (ha)			Density (units/km^2)		
Study area	Cover Class	1987	1990	% change	1987	1990	% change
Experimental	Upland grass	0.83	0.91	+9.6	9.6	8.9	-7.3
	Margin grass	0.31	0.27	-12.9	10.2	5.9	-42.2
	Total grass[1]	0.56	0.65	+19.6	19.8	14.8	-25.2
	Woodland	0.21	0.33	+57.1	19.6	10.4	-53.0
	Wetland	0.17	0.14	-17.6	84.8	83.6	-1.4
Control	Upland grass	0.88	1.07	+21.6	14.1	12.2	-13.4
	Margin grass	0.32	0.39	+21.9	12.5	8.0	-36.6
	Total grass[1]	0.61	0.80	+31.1	26.6	20.2	-24.3
	Woodland	0.27	0.36	+33.3	26.3	17.1	-65.1
	Wetland	0.13	0.10	+23.1	98.0	96.4	-1.6

[1] Total grass excludes right-of-way grass.

Wetlands are a major component of existing native habitat on farmlands of the RM of Antler, Walpole, and Maryfield. In spite of agricultural encroachments, wetlands occupied 825 ha (14.5%) and 341 ha (13.2%) of the experimental and control area transects in 1987 (Figure 2 and 3). The average sizes of wetlands were 0.17 and 0.13 ha (Table 2), with more than 75% of wetlands smaller than 0.2 ha. In 1987, on the experimental area, 6% of the wetland basins and 75% of the wetland margins were cultivated. In addition, combined land use practices, such as cultivation, clearing, and filling, affected 26% of the wetland basins, and impacted the margins of 79% of the wetlands (Adams et al. 1992).

The remainder of the landscape was comprised of right-of-way vegetation which is not likely to be altered by land use practices, cultivated land, and other cover which was comprised of brush, farm yards, and disturbed sites (Figure 2 and 3).

LAND COVER CHANGE 1987-1990

Land use activities, in concert with drought through 1988 and 1989, exerted considerable impact on land cover change in the experimental area by 1990 (Figure 4). A 4.3% increase in the area cultivated represents a total gain on the sampled area of 155 ha. Much of this gain may have been contributed by agricultural encroachment into dry wetlands, as wetlands decreased in mean size from .17 to .14 ha (Table 2) and accumulated area declined by 178 ha (-21.7%). By the spring of 1989, 68% of the wetlands were affected by combined agricultural activities and 43% of the wetland basins and 83% of margins were totally or partially cultivated (Adams et al. 1992). During 1981 to 1985, Turner et al. (1987) documented average incidences of 59% of basins and 78% of wetland margins affected by agricultural practices on waterfowl survey transects in southern Saskatchewan. Corresponding declines of 50.5% occurred in area of marginal grasslands resulting in a net loss of 91 ha. Areas of upland grass (combined native and tame) showed a net increase of 6.5 ha, chiefly due to gains of reseeded pasture or forage, although numbers of grassland patches actually decreased (Table 2). Woodland areas decreased by 38 ha. Therefore, native vegetation cover comprised of grass margins and woodland showed a minimum net loss of approximately 129 ha on the study area transects.

On the control area, land cover changes affected by land use practices were not quite as extensive as on the experimental area (Figure 5). The amount of cultivated land increased by 3.7% or 52 ha. Wetlands showed a similar proportional loss in total area (84 ha) due to agricultural impacts and to reductions in mean size (Table 2) caused by water level declines. Reductions in area of grass margins at 23% were not as

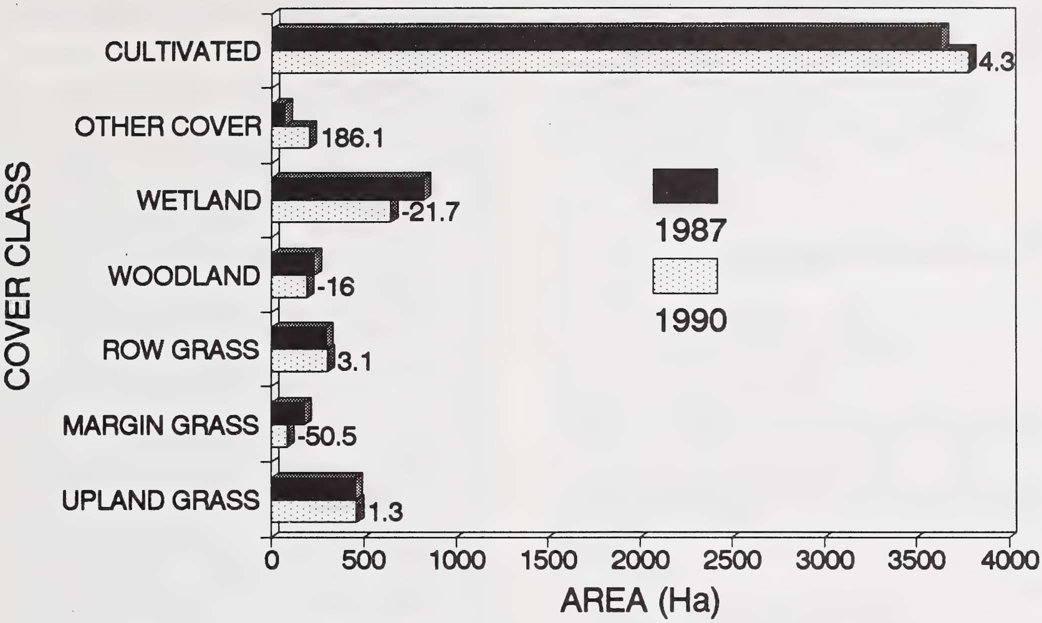

Figure 4. Changes in area of land cover classes in Antler Municipality, 1987 and 1990.

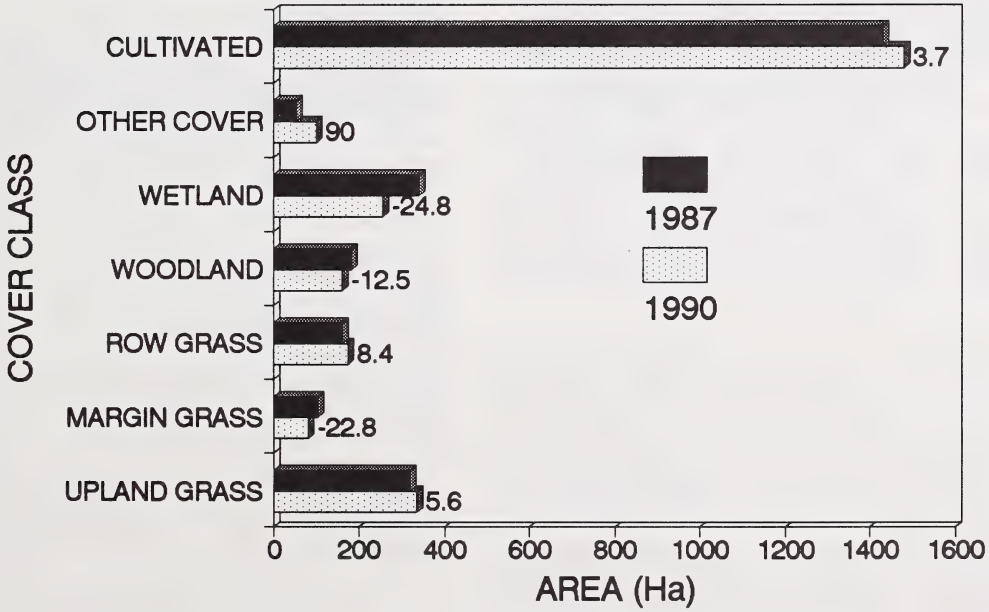

Figure 5. Changes in area of land cover classes in Walpole and Maryfield Municipalities, 1987 and 1990.

extensive as on the experimental area, as shown by the loss of only 24 ha. However, upland grass increased by 17.8 ha or 5.6%, and woodland decreased by 23 ha or 12.5%. In contrast to the RM of Antler, these trends indicate that land use on the control area is more diversified as reflected in increased forage land.

Cover Patch Diversity

Dynamic annual shifts in area of cover classes can occur due to land use-weather interactions, or to conversion of one class to another by clearing, cultivating, or reseeding. As a result, net changes in areas of grassland classes may be masked by gains and losses. Assessment of diversity is another method of determining changes in habitat by means of measuring fragmentation of cover due to land use impacts. Diversity is expressed herein as the distribution and mean size of cover classes, or cover patch units per km^2 (Table 2).

Mean cover patch units on uplands were usually less than 1.0 ha, but patch size appeared to increase slightly between 1987 and 1990 on both study areas. These shifts in mean size were probably related to the destruction of more of the smaller units as total grass units decreased by 24 or 25%. On both areas the grass margin was the grassland class most severely reduced by 1990. Similarly, woodland patches also increased in mean size but densities showed substantial decreases, indicating that clearing impacts were more extensive on the control area which supported the greatest area of woodland. Therefore, diversity of upland cover is highest on the control area, although habitat diversity is deteriorating on both study areas. What may be important is that the rate of change for upland grass on the control area is almost double the rate on the experimental area.

Wetlands that were the most frequently occurring and had the most diverse cover patches on the study areas, were more numerous on the control area. Although modified by land use, few wetlands were totally eradicated. Decreases in mean size from 1987 to 1990 reflected drawdowns in water levels from once flooded basins to recessional shorelines, and consolidation into smaller units. The vegetated borders of wetlands including wet meadows and grass margins gradually adjusted during the interval or were decimated by farming practices.

Cover Conversions in the Antler Municipality

The short-term effectiveness of the Prairie Pothole Project to restore or protect native habitat can be evaluated by comparing the amount of agricultural conversion to the amount of habitat restored, or protected, in the municipality during the 1986 to 1990 interval. Estimates of the total amount of grassland on private lands in the municipality were derived from prorating grassland hectares on the transect area to the entire study area after deducting 2850 ha of unimproved Crown land. In 1990, the total estimated grassland, excluding rights-of-way, in the municipality was 7560 ha. During the 1987 to 1990 interval, net losses of grassland were projected to be approximately 1170 ha. Counteracting these losses were the protection by lease or easements of 623 ha of idled pasture and the conversion of 202 ha of cropland to seeded grassland (SNR). Following losses of about 566 ha, the remaining woodland present in 1990 occupied about 2750 ha. However, blocks of woodland comprise most of the 2850 ha of Crown lands, part of which is designated "critical wildlife habitat." Except for Crown lands which occupy only 3.5%, the extent of existing native habitat and grasslands within the municipality of Antler is under threat to agricultural conversion, in spite of efforts through habitat restoration programs to reverse this trend.

Rates of loss of parkland habitat are high and are continuing in the municipality, although extensive habitat retention programs have preserved some patches of prairie and parkland. The extent of fragmentation of parkland habitat as discussed by Rowe (1987), is probably more serious in southeastern Saskatchewan in the 1990s as indicated by the low percent coverage (3.4 to 6.2%) and substantial reductions in patches of woodland (Table 2). Small habitat complexes which include tracts of grassland and woodland filling interstitial spaces among associated wetlands, are disappearing due to agricultural conversions. These losses reduce biodiversity by affecting habitat utilized by waterfowl, upland game birds, passerine birds, and White-tailed Deer (*Odocoileus virginianus*). It is uncertain whether habitat enhancement programs aimed at restoring waterfowl nesting habitat will be able to protect the remaining parkland ecosystems in heavily farmed regions.

ACKNOWLEDGMENTS

Habitat evaluations in the Prairie Pothole Project have been supported by grants and operating funds from Wildlife Habitat Canada, CWS, and the North American Waterfowl Management Plan. Field surveys were conducted by R. Russell, G. Bain, K. Eskowich, D. Pochailo, P. Rakowski, G. Trottier, G. Gentle, and D. Duncan. Maps were drafted and prepared by G. Bain, A. Whyte, and T. Heine. Data processing and digitizing were conducted by K. Eskowich, D. Pochailo, A. Whyte, and L. Li. Aerial photography was provided by DU and Airquest Resource Surveys.

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MONITORING NATIVE PRAIRIE - SESSION DISCUSSION

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On the utility of satellite data, J. Polson suggested that different user groups should be more interested in getting together to share costs, data needs, and information. Also, the accessibility to the computer part of the system is not easy. Training of technicians in analyses procedures will improve access. LANDSAT imagery is not affordable for a small user. LANDSAT methodology is more cost effective and more feasible for interagency use, especially as a mapping tool. Intensive survey programs are not working. What other options do we have?

Should we focus efforts on saving marginal lands or good quality grasslands? Over the years (via man or grazing), we have lost tremendous diversity in our native plant areas. Perhaps there are very few areas, if any, which we can class as being truly native. We need to identify tracts of prairie vegetation and determine composition of native plants. Should we preserve and manage already modified grasslands? There are not many native grassland areas remaining, especially in the sand hills.

How long does it take to restore prairie habitat? At Manyberries, at least 55 years was required to restore biological diversity on heavily grazed mixed grass prairie. Some areas may never be restored to pristine conditions. It is doubtful that we could ever restore very rare plant species.

Steps to identify and manage existing native grasslands. We should start monitoring not only the quantity but the quality of remaining grasslands. Government agencies should continue to be involved, but a participatory framework is needed to involve the farmer/rancher who owns or manages the land. Indicator plant species should be selected and monitored for native prairie types on localized landscapes. Management of existing prairie should involve controlled burns.

Steps to preserve prairie habitat. Local people need to be involved in stewardship of prairie. Through fostering pride of ownership of prairie, local people develop a stake in prairie conservation. How do we get people involved? Local landowners lack expertise in managing grasslands; therefore an educational program is necessary. We must change attitudes of people toward land, and promote awareness of why society should retain native species. Conservationists have to learn to understand agricultural people. Various financial incentive programs need to be developed to interest landowners. Perhaps we should look at options such as the American "Sodbuster Law." We must also change environmentally negative agricultural policies and programs such as Gross Revenue Insurance Programs and Net Income Stabilization Account that are based upon acreage quotas.

Land use impacts on habitat. Assuming we return to the "good water years" of the late 1940s and early 1950s, what percent of impacted sloughs/wetlands would be lost permanently? This is difficult to say, but up to 40% of wetlands may have been lost in some regions. Other impacted wetlands would require more than two years of flooding to restore dominant native plant species.

Are we changing the evolutionary process? Is conservation of ecosystems interfering with a natural process which leads to evolutionary extinction of species?

MILITARY TRAINING AND CONSERVATION ON CANADIAN FORCES BASE SHILO, MANITOBA

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Canadian Forces Base (CFB) Shilo is located 25 km east of Brandon in southwestern Manitoba. Bounded on the south by the Assiniboine River and on the east by Spruce Woods Provincial Park, Shilo encompasses some 39,000 ha, primarily provincial Crown land. The military base, and the provincial park, both lie in a physiographic area known as the Upper Assiniboine Delta. Characterized by lacustrine or aeolian deposits of sand, formed from the Assiniboine River discharging into glacial Lake Agassiz some 12,000 years ago, the landscape at Shilo encompasses open unstabilized sand dunes, stabilized dunes with a combination of aspen parkland and prairie vegetation, and flat open areas of mixed grass prairie.

In the early 1900s, the Department of National Defense (DND) began training at Shilo and has used the area ever since. Primarily a training base for artillery and infantry troops, Shilo was relatively unaffected by military training activity for many years. In 1973, however, a North Atlantic Treaty Organization (NATO) agreement between Canada and the Federal Republic of Germany permitted both mobile artillery and tank training on Shilo during the summer and early fall of each year. This consistent use, in addition to training by Canadian Forces and militia, is more intensive than since the period during World War II.

As a result of the 1973 agreement with Germany, a new federal-provincial lease agreement was signed, and subsequently renewed in 1983, which stipulated (among several conditions) that DND: 1) conducts an ongoing program of decontamination of explosives; 2) maintains a program of fire prevention, detection, and suppression; 3) restricts military use and vehicular traffic in the Bald Head Hills and Epinette Creek, areas that are ecologically sensitive or difficult to access.

The Department of Natural Resources (DNR), the provincial department responsible for Crown land administration: 1) reserved the right to provide wildlife use programs (primarily hunting seasons) in accordance with safe periods on the training area; 2) reserved the right to permit timber cutting in selected areas; and 3) reserved the right to issue annual hay or grazing permits on Crown land not used by DND.

The agreement also calls for joint cooperation and participation on the Shilo Environmental Advisory Committee (SEAC), established to advise the Commander of CFB Shilo and the Minister of DNR on environmental and resource issues and concerns. The committee is composed of biologists, botanists, resource planners, and military staff from federal and provincial agencies as well as the University of Manitoba and the Manitoba Museum of Man and Nature.

SEAC meets two or more times each year to review program proposals and changes in military training plans. The Base Commander has often requested specific advice on the potential impact to the environment of proposed changes in the military training program or related activities. Although there is frequent turnover in the military staff representatives to SEAC, the majority of representatives from other agencies has remained consistent since the committee was established. This continuity has enhanced the ability of SEAC to function as originally proposed. To further clarify the role of SEAC, Terms of Reference were signed by the Base Commander and Minister of DNR in 1990.

Background information and detailed biological and botanical data for the wildlife species and different eco-types present on Shilo was scarce or nonexistent at the time SEAC was formed. When advice was sought by military staff, the SEAC members could only recommend that biological studies be carried out as a means of providing sound answers. The initial lease agreement did not assign responsibility for financial support for such studies which were necessary if SEAC was to provide recommendations and advice to the Base Commander and the Minister of DNR.

As the need for specific studies were identified, cooperation of a number of agencies has enabled completion of a broad spectrum of studies. Through the contribution of direct funding, staff, facilities, and equipment, the governments of West Germany, Canada (through DND), and Manitoba, the World Wildlife

Fund (Canada), the University of Manitoba, and the Museum of Man and Nature, have enabled research and management efforts to be completed.

Wildlife studies or management efforts have been completed on Elk (*Cervus elaphus*), the little known Western Hognose Snake (*Heterodon nasicus*), Northern Prairie Skink (*Eumeces s. septentrionalis*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Swift Fox (*Vulpes velox*); population inventories and distribution studies of Moose (*Alces alces*), Elk and White-tailed Deer (*Odocoileus virginianus*), and nongame bird population inventories.

Ecological studies have focused on: 1) the distribution and frequency of Leafy Spurge (*Euphorbia esula*); 2) the effects of fire on native plant communities; 3) the effects of fire on the abundance of undesirable non-native plants; 4) the effects of tank traffic on plant cover and soil compaction; 5) the relationship between soil disturbance and Leafy Spurge abundance; 6) the identification of principal vegetation types within the Shilo military reserve; 7) the vegetative changes on Shilo for the period covered by the NATO agreement; and 8) reclamation measures for the revegetation of damaged tank battleruns.

Canadian military training is largely restricted to the use of artillery, most of which takes place from fixed locations on the western and northern fringes of the training ranges. Impact areas are in the central portion of the base which has rough topography and forest, or tree/shrub cover. Infantry training takes place throughout the base, primarily using wheeled vehicles but with some tracked armoured personnel carriers.

German military training, for the most part, has been confined to several flat or undulating mixed grass prairie areas on the western and southern limits of the ranges. German training is centred around the use of the Leopard Tank and the Marder; both heavy tracked vehicles. To date, the method of tank training has been restricted to straight line shooting at targets spread along the length of the open prairie "battleruns." These areas were deemed to have the greatest trafficability as well as the open expanses needed at the onset of German training in 1974.

German forces have been extremely cooperative in adhering to a caution against power turns while maneuvering along the length and breadth of the individual battleruns, thus minimizing or preventing vegetation and soil disturbance, and subsequent wind erosion. Unfortunately, the necessity of intensive training required for several thousand troops each summer, and the relatively narrow width of each battlerun has left little opportunity to avoid use of a portion of each battlerun as has been suggested. For many years, the principal battleruns were the only prairie areas affected. Several areas on the western and southern periphery of the base, also native prairie, received little, if any tracked vehicle traffic.

In recent years, however, changes in economic conditions and military strategy in Germany have dictated changes in training at Shilo. The majority of fires on Shilo during the training season are caused by tank ammunition. A decrease in the amount of live firing should decrease the fire frequency on the native prairie and on the adjacent aspen/shrub landscape. This reduction in the amount of live firing tank training has led to the desire to use more of the "dry-training" native prairie areas on the base periphery.

It is the latter activity, coupled with the wish to undertake more tactical type of dry training with tracked vehicles in other areas of rougher terrain, that has led DND to recently conduct an environmental evaluation of Germany's proposal. The results of this evaluation have not yet been completed, nor have any final decisions been made as to future German usage of areas other than the traditional battleruns.

When military training on CFB Shilo intensified dramatically in the early 1970s, there was mutual concern by military staff, natural resource and environmental managers, ecologists, and the public on the potential affects of increased training activities on the wildlife, and the unique sandhill and prairie landscape of Shilo. It would be foolish to suggest that there have been no changes and no impacts, because there have. It is understood that DND has a mandate, and Canada has had a commitment to its NATO allies, to train troops within limits set by economics, military strategy, and political changes on a national and global scale. The economy of southwestern Manitoba has benefitted substantially from a military presence and the agreements still in place. All of these factors come to bear on how CFB Shilo has been used and will continue to be used in future.

To date, the cooperation between DND, DNR, other federal and provincial agencies, and the SEAC has been substantial. There have been periods, or instances of disagreement or difficulty, but after almost two decades of intensive military training by Canadian and German forces, many of the initial fears have been allayed. A substantial body of information now exists upon which to formulate recommendations and cooperation continues between the agencies involved. As an advisory body, the SEAC can only provide the best recommendations possible on use of this fragile prairie ecosystem; it can advise and educate, but not legislate, on the ultimate use of any portion of Shilo. The maintenance of this ecosystem, and its valuable floral and faunal constituents, will be a challenge to those faced with the responsibility of making decisions while striving to accommodate the realities of military training and the need for prairie conservation.

THE LAST MOUNTAIN LAKE NATIONAL WILDLIFE AREA - PAST, PRESENT AND FUTURE

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INTRODUCTION

Best known for its spectacular concentrations of hundreds of thousands of fall migrant birds, particularly waterfowl and Sandhill Cranes (*Grus canadensis*), the Last Mountain Lake National Wildlife Area (NWA) also supports a host of other species of prairie wildlife. Home of the first bird sanctuary in North America (established in 1887), the area has a fascinating history spanning over 100 years. This talk will explore the past, present, and future conservation issues at Last Mountain Lake which affect this unique area as well as many other prairie sites.

THE PAST - A HISTORICAL REVIEW

In the years before 1887, the grassland and wetland habitats at the north end of Last Mountain Lake supported a rich variety of prairie wildlife. For hundreds of years aboriginal peoples made a living off these resources. In 1690, European exploration entered the region followed by fur traders in search of beaver and other wildlife to satisfy the fashion trends of the period. Fur trading at posts like Last Mountain House was at its peak from the late 1700s to the late 1800s across the prairies (Hendry 1987). In July 1869, Isaac Cowie, a clerk with the Hudson's Bay Company, passed through one of the last great herds of American Bison (*Bison bison*) at the north end of Last Mountain Lake. He (1913, page 373) wrote: "They blackened the whole country, the compact moving mass covered it so that not a glimpse of green grass could be seen. Our route took us into the midst of the herd, which opened in front and closed behind the train of carts like water round a ship.... So we travelled among the multitudes for several days." In 1879 John A. Macoun (1882), the botanist, wrote of the north end of Last Mountain Lake: "Multitudes of pelican, geese, ducks, avocets, phalaropes, waterhens, and grebe, besides innumerable snipe and plover were everywhere, in the marshes at the head of the lake or along its shores, or on small islands lying to the south of the camp. This was early in July and experience tells me that not one tenth was then seen of the bird life assembled in September and October." The wildlife of the prairies seemed limitless.

But the winds of change had already arrived (Foster 1978, Hewitt 1921). By 1879 the great herds of Bison were gone and by 1884 only scattered animals remained; the last wild Bison in prairie Canada apparently being shot before 1890. By 1880, Eskimo Curlew (*Numenius borealis*), Hudsonian Godwits (*Limosa haemastica*,) and Lesser Golden-plover (*Pluvialis dominica*) populations had crashed. By 1900 the Labrador Duck (*Camptorhynchus labradorius*), Great Auk (*Pinguinus impennis*), and Passenger Pigeon (*Ectopistes migratorius*) were all but extinct and many other species were becoming rare including Whooping Crane (*Grus americana*), Trumpeter Swans (*Cygnus buccinator*), Wood Ducks (*Aix sponsa*), and Great Egrets (*Casmerodius albus*). Many factors were the cause of these declines including market hunting and the plume trade supplying colourful bird feathers for milliners to make fashionable hats (Foster 1978). In this climate North Americans began to be concerned with broad conservation issues.

A letter written in March 1887 by the Lieutenant Governor of the North-West Territory, Edgar Dewdney, to the Minister of the Interior, Thomas White, in Ottawa concerning Last Mountain Lake perhaps constitutes Canada's first environmental impact assessment (Public Archives of Canada and Canadian Wildlife Service [CWS] historic files). Concern over construction of the railroad into the district and the accompanying settlement caused Dewdney to recommend reserving the islands near the north end of the lake for "these islands are the favorite breeding grounds for almost all the different varieties of wildfowl we have in the North-West, from pelicans to snipe.... The shores of the islands are literally covered with eggs in the breeding season" (ibid.). With considerable foresight, on June 8, 1887 Sir John A. MacDonald and his government set aside some 1025 ha of land including islands, peninsulas, and shores as "breeding grounds for wildfowl" (ibid.).

The reservation of additional lands for federal bird sanctuaries in the prairies did not take place until later (1911 to 1915): 12 lakes in Saskatchewan (including Quill, Lenore, Redberry, and Old Wives lakes), 14 in Alberta (including Pakowki, Miquelon, Ministik, and Many Island lakes), and none in Manitoba. With the signing of the historic treaty for the protection of migratory birds between Canada and the United States in 1916 and passage of the Migratory Birds Convention Act (MBCA) in 1917 over 400 species of birds were protected. In 1917 and 1918, R.M. Anderson reviewed these prairie lakes for the federal Advisory Board in Wild Life Protection and reported on their suitability as sanctuaries. Sanctuary status was afforded 7 lakes in Alberta in 1920 and 12 lakes in Saskatchewan in 1925, including surrounding uplands. In 1925, additional lakes in Alberta, Saskatchewan, and Manitoba were reserved as Public Shooting Grounds to compliment the sanctuaries, protect more habitat and "to foster a spirit of sportsmanship" by discouraging excessive hunting. It was the first comprehensive system of wetland and wildlife stewardship in the prairies (Hewitt 1921).

The severe drought of the 1930s began to unravel these landmark conservation efforts. Pressure from the agricultural community was extreme. In 1951, the Public Shooting Grounds were abolished. Between 1946 and 1956 several sanctuaries were delisted and replaced by smaller ones. But the most devastating blow was the loss of nearly all upland habitat around the sanctuaries. Some 66,000 acres of sanctuary land in Saskatchewan was reduced to less than 4000 acres. Only at Last Mountain Lake was the upland retained relatively intact (Murry 1966, Taylor and Jorgenson 1985).

In the 1960s, the CWS began to acquire migratory bird and wildlife habitat for permanent protection at Last Mountain Lake and other sites across Canada. The Canada Wildlife Act (CWA) (1973) enables the CWS to manage these areas as NWAs using stronger, yet more flexible, habitat and wildlife conservation regulations than afforded the sanctuaries under the MBCA (1917). Today, across Canada there are approximately 100 Migratory Bird Sanctuaries and 50 NWAs totalling over 113,000 km^2, with more being added each year. The sanctuaries and NWAs comprise the lands protected and administered by CWS, for wildlife conservation purposes.

The year 1987, the centennial of the Last Mountain Lake Bird Sanctuary, afforded Canadians the opportunity to rededicate themselves to conservation of wildlife and their habitats. With tremendous public and nongovernment support, "Wildlife '87: Gaining Momentum" became a reality. On June 5, 1987 His Royal Highness, Prince Philip witnessed the signing of an agreement between the Governments of Saskatchewan and Canada to assign the lands at the north end of Last Mountain Lake for a NWA (Taylor 1987). Since that date, the titles to provincial lands have been transferred to Canada and our federal Department of Environment is in the final stages of legally declaring the site as a NWA.

THE PRESENT - CONSERVATION PLAN AND PROGRAMS

To address the many challenges facing the Last Mountain Lake NWA, the CWS is developing a Resource Conservation Plan (RCP) which will guide the NWA into the 21st Century. An opportunity for public review and comment on the plan will be offered to interested groups and individuals later in 1992. Guiding the plan's preparation are the Terms of the Agreement with Saskatchewan, the CWA, several international agreements for the protection of migratory bird habitats, and our on site management experience over the past 25 years.

The primary purpose of the Last Mountain Lake NWA is to protect and enhance the variety of habitats for wildlife. It is the underlying policy which guides all management programs and activities on the area. The RCP addresses four main management topics: upland habitat conservation; wetland habitat conservation; wildlife conservation; public use and information.

Upland Habitat Conservation

These management programs focus on the protection and enhancement of native habitats. Mixed grass prairie and western snowberry shrub communities typically dominate uplands with higher sites supporting fescue grassland species and lower sites supporting saline tolerant species.

One of the most effective management tools in native grass management and enhancement is fire. Prescribed burning can be used to simply reduce fuel loads and litter build up on an area; to control the spread of exotic and undesirable plant species; to encourage seed production; and to alter plant succession.

We have used fire on the NWA as a management tool for over 10 years. A five-year research project by E.A. Driver (CWS, Saskatoon) monitored the effects of fire on plants, birds, and small mammals and will serve to guide our use of fire. Fire benefits many wildlife species including Baird's Sparrow (*Ammodramus bairdii*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Burrowing Owl (*Athene cunicularia*), shorebirds, and waterfowl by improving nesting cover and food availability (Driver 1987). The results of this work are being applied across the prairies at places like the Living Prairie Museum in Winnipeg, the Grasslands National Park, and the Fescue Prairie in Saskatoon.

Upland sites which have suffered degradation on alteration on the NWA are candidates for restoration. Dean Nernberg (1991) a graduate student at the University of Alberta undertook an inventory of the grassland communities on the NWA, studied germination and growth rates for grasses to be used in reseeding and prepared a "restoration manual" to guide the work at Last Mountain Lake.

Studies into the relationships between agriculture and wildlife have been of special interest at Last Mountain Lake for over 25 years and have included research on crop damage, rest rotation grazing, and deferred hay cutting (CWS Saskatoon, unpublished). Brenda Dale's work on hay cutting is a part of one of the special sessions of this workshop. Grazing and haying when applied carefully can be used as wildlife management tools for the mutual benefit of wildlife and man.

Wetland Habitat Conservation

These management programs focus on maintaining the wide variety of wetland habitats represented at Last Mountain Lake: from deep lake and marsh waters to shallow flooded meadows; from freshwater springs and fens to saline shorelines and basins.

Within the NWA, several basins have controlled water levels to simulate natural water fluctuations which have occurred on the area in the past. Water control projects upstream and downstream (Last Mountain Lake proper) have reduced the natural cycles of flooding and drying on the area. Through the joint efforts of CWS, Ducks Unlimited (DU), and the North American Waterfowl Management Plan (NAWMP), the wetland management program on the area is being improved steadily. An effort has been made to provide examples of most of the basic wetland management techniques used across the prairies at Last Mountain Lake: construction of dams, dykes, and related water control structures; construction and blasting of small wetlands; placement of artificial nesting structures; building nesting islands; level ditch excavations; and water manipulation through the use of pumps and natural water flows.

Wildlife Conservation

These programs focus on maintaining a diversity of prairie wildlife while ensuring that endemic, often rare, species, which have specific habitat requirements, are protected.

The north end of Last Mountain Lake is a major staging area for hundreds of thousands of water birds. Up to 400,000 geese of four species, uncounted ducks, and 50,000 Sandhill Cranes have been recorded using the area at one time. The area is particularly important during drought years. Some 270 species of birds have been recorded for the area with over 100 of these staying to breed (Dale 1987).

Besides its values as a migration stopover and breeding area, Last Mountain Lake provides appropriate habitat for nine of Canada's 31 species of vulnerable, threatened, or endangered birds as classified by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). The species include Peregrine Falcon (*Falco peregrinus*), Piping Plover (*Charadrius melodus*), Whooping Crane, Burrowing Owl, Ferruginous Hawk (*Buteo regalis*), Loggerhead Shrike (*Lanius ludovicianus*), Cooper's Hawk (*Accipiter cooperii*), Baird's Sparrow, and Caspian Tern (*Sterna caspia*). Most notable are the high breeding populations of Loggerhead Shrikes and Baird's Sparrows on and around the NWA. Both prefer taller, less disturbed grasslands.

A wide variety of monitoring and research projects have been done on birds at Last Mountain Lake. These include broad ecological studies on waterfowl nesting, staging and feeding; grassland passerines, breeding and staging; shorebirds and sensitive colonial birds; and single species studies like the Sandhill Crane, Loggerhead Shrike, Sharp-tailed Grouse, and Wilson's Phalarope (*Phalaropus tricolor*). Major long-term banding programs are underway on waterfowl (prairie nesting ducks) and migrant passerines. The latter known as the Last Mountain Banding Station will as one of its aims monitor changes in populations of neotropical migrants.

Less well-known are the 33 mammal species (Jorgenson 1987) and six herptile species recorded for the area. A preliminary listing of plants found on the area totalled over 300 species of which seven are considered rare in Canada (Caldwell et al. 1987). Species of concern include mustelids like the Long-tailed Weasel (*Mustela frenata*), the Leopard Frog (*Rana pipiens*), Upland White Goldenrod (*Solidago ptarmicoides*), and Golden Currant (*Ribes aureum*).

Public Use and Information

These programs encourage people to visit the area at times and in ways which can be sustained over time. Most public uses are limited to portions of the NWA at any given time.

The NWA is open to the public during daylight hours. Strictly regulated, hunting, sport fishing, boating, and vehicle use are permitted on portions of the area. Non-consumptive uses such as photography, hiking, and nature observation are encouraged. The public information program presently consists of an information kiosk (with displays, brochures, and guest registration), a 14 km self-guided driving tour, wetland nature trail, grassland nature trail, observation tower, and information signs. The public are also invited to participate in the banding station activities at the Last Mountain Regional Park.

These information programs focus on wildlife management programs and ecological relationships found at Last Mountain Lake plus national and international conservation programs linked to the area: International Biological Program Site status (1970); Ramsar Wetland Status (1982); National Historic Site (1990); Western Hemisphere Shorebird Reserve Network Candidate Site.

THE FUTURE

Last Mountain Lake is one of the lucky places where its biological values have been recognized for a long time and concrete efforts to protect the site are in place. However, it serves as an example of how difficult it is to conserve a critical site. Over 120 years have elapsed between Isaac Cowie's experience with an estimated three million Bison at the north end of Last Mountain Lake and its permanent protection as a NWA.

By protecting the diverse habitats and wildlife species using Last Mountain Lake we hope to continue to contribute to the Prairie Conservation Action Plan (PCAP) (World Wildlife Fund [WWF] 1988). The RCP for the NWA has incorporated many of the concepts promoted under the PCAP.

We will continue to rely on partnerships in conserving Last Mountain Lake. To date the list of cooperators is lengthy: the Saskatchewan Parks and Renewable Resources, Wildlife Branch, three universities and one technical college, various municipal governments, Wildlife Habitat Canada, DU, the NAWMP partners, the Saskatchewan Natural History Society, the Saskatchewan Wildlife Federation, WWF, and numerous local residents, naturalists, and interested individuals. To them we extend our thanks, and we look forward to the challenges of the next 100 years.

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GRASSLANDS NATIONAL PARK - STATUS OF LAND ACQUISITION AND MANAGEMENT CHALLENGES

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The signing of the Federal/Provincial Agreement on September 23, 1988 to establish Grasslands National Park (GNP) marked the end of years of political wrangling. The signing also marked the conclusion of a very persistent and successful lobbying campaign by conservation groups which began 30 years earlier. The agreement is also significant because it introduced a few new wrinkles in the normal process of establishing national parks.

For the first time water courses would not form part of the proposed national park and administration and control of the lands comprising the water courses will remain with Saskatchewan. It was further agreed that such lands would be managed to compliment national park purposes. The nine streams affected by this clause have been surveyed and legal survey plans are being prepared to delineate the lands involved. The exclusion clause will be re-examined on each 10 year anniversary of the signing of the agreement for the next 30 years.

Another first in the agreement was the requirement by Canada to purchase leasehold and freehold interests directly from current operators and owners. The agreement specifies that Canada shall acquire lands on a willing buyer - willing seller basis and that expropriation shall not be used.

I am happy to report that through this new process the Canadian Parks Service (CPS) has acquired nearly one half of the lands proposed for GNP. To date 31 landowners have requested appraisals, all but one is complete. Negotiations have been held with 29 and 24 signed options received (Table 1).

Table 1. Lands acquired for Grasslands National Park.

	IN	OUT	TOTAL
West Block			
Prior to 1989	49.25	5.25	54.50
Since 1989	43.25	13.50	56.75
*Crown Land	8.00		8.00
Total	100.50	18.75	119.25
East Block			
Since 1989	61.25	25.50	86.75
*Crown Land	7.00		7.00
Total	68.25	25.50	93.75
TOTAL	168.75	44.25	213.00
	79.0%	21.0%	

(area is expressed in sections - sq. mi.)

*Land which is owned by the Crown and will not require purchase

NOTE: Land available for GNP 48%

Figures 1 and 2 display the distribution of acquired lands.

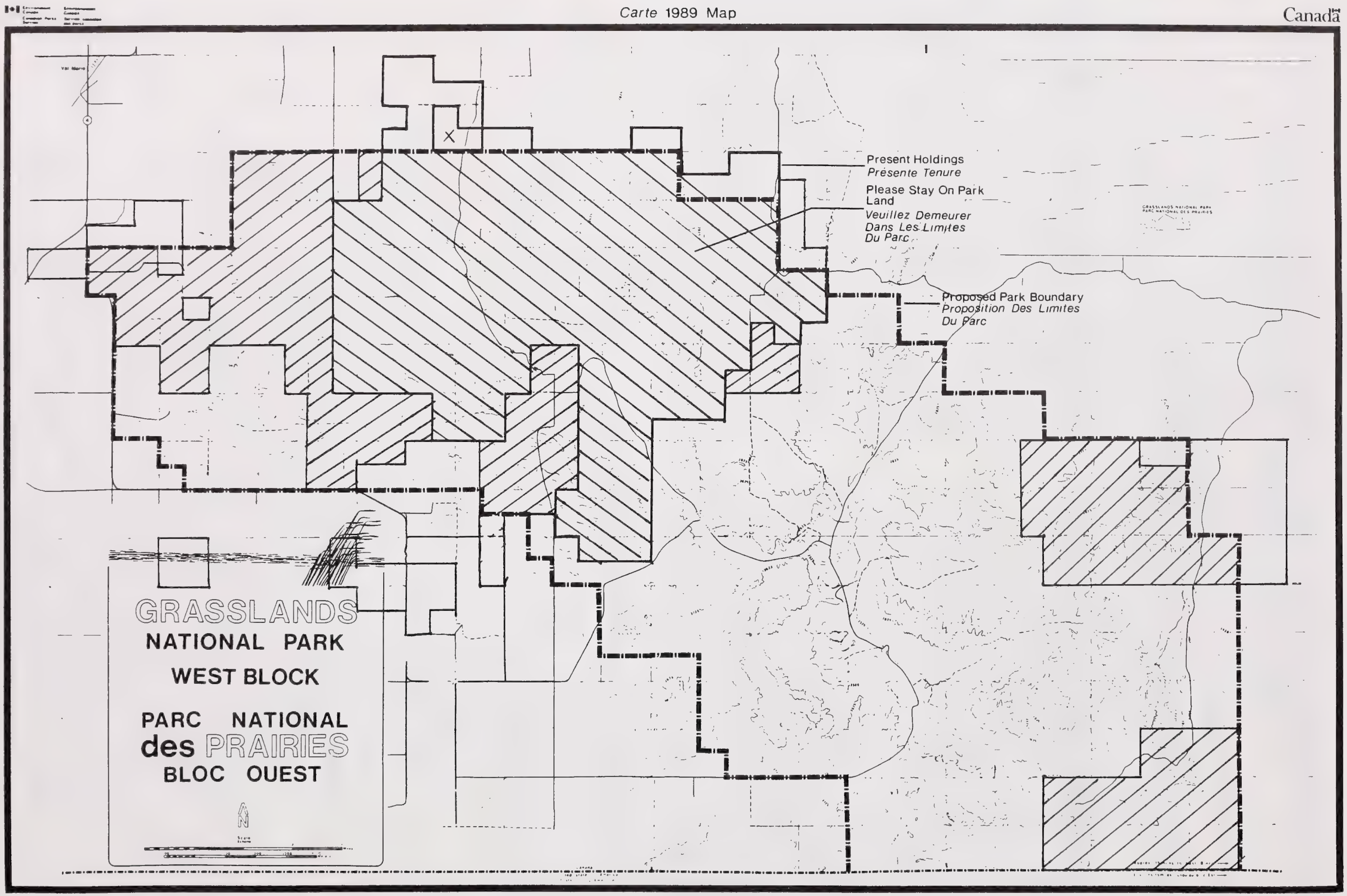

Figure 1. Grasslands National Park, West Block

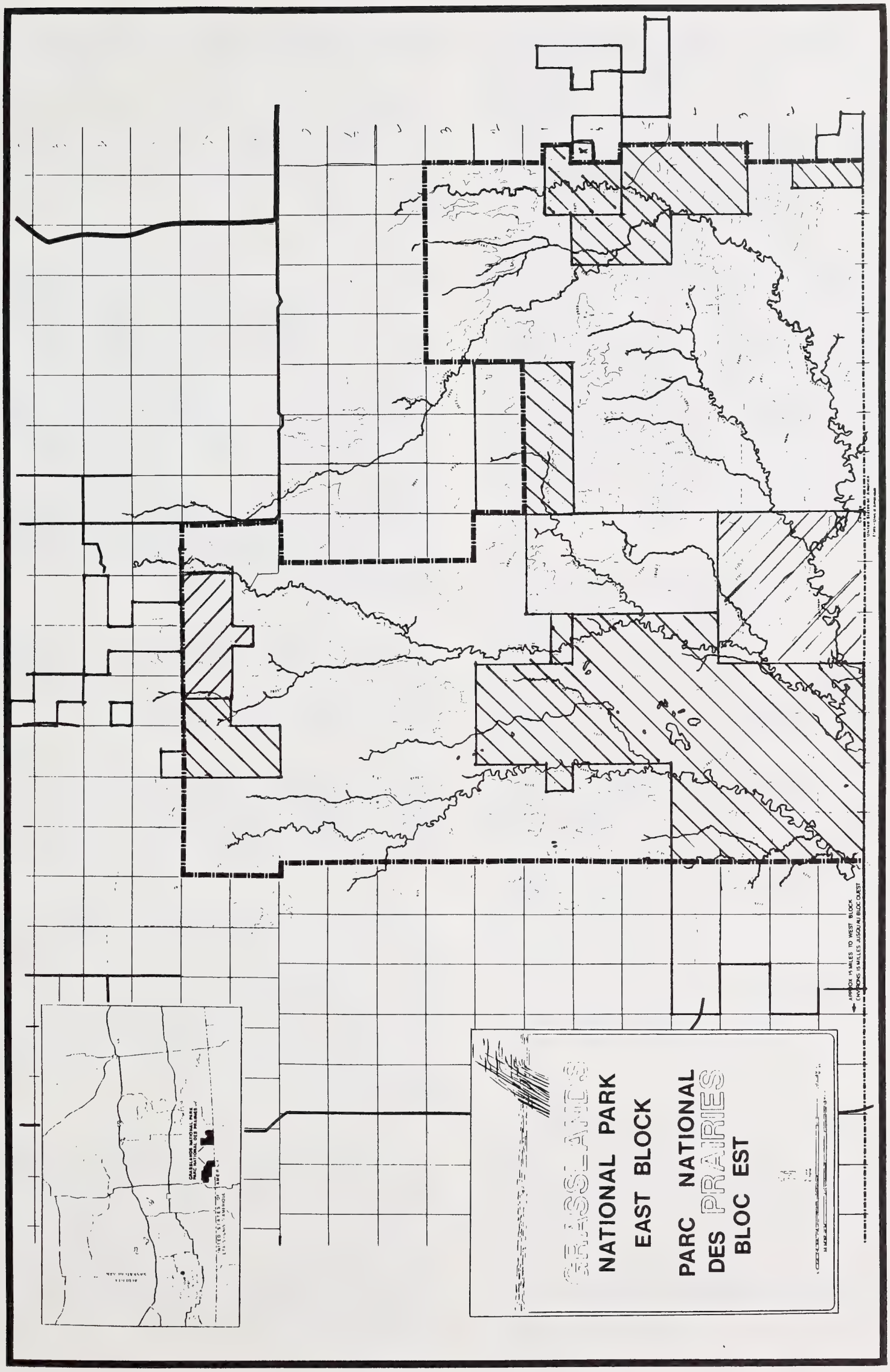
GRASSLANDS
NATIONAL PARK
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Figure 2. Grasslands National Park, East Block

The 1988 agreement is unique in its provisions for mineral exploration. Exploration permits on lands outside the core area were to be issued in the nine month period following the signing. No permits were applied for; consequently Saskatchewan placed all of the proposed park lands in a mineral reserve on July 21, 1989. No mineral exploration could take place except on lands which were previously encumbered.

Dating back to the Hudson's Bay Company Charter and subsequent agreements, mineral rights to 2077 hectares were held by a group of oil companies. This ownership could frustrate the legal establishment of GNP because mineral rights to all acquired lands could not be transferred to Canada. Through the efforts of the Nature Conservancy of Canada (NCC), AMOCO Canada and partners transferred their interests to NCC on condition that these would be also transferred to Canada. The donation was duly celebrated in Regina on January 13, 1992.

Progress has also been realized in areas of research, planning, and operations. The Interim Management Guidelines which provides guidance to park managers pending the approval of a formal park management plan, has been approved. The formal planning program is scheduled to commence in 1993/1994. A soil survey has been completed by the Saskatchewan Institute of Pedology and their report is due March 1, 1992. Archaeological survey of much of the acquired lands has been conducted for two field seasons. This program will continue as land is acquired and funds permit. Discussions are proceeding with numerous agencies regarding the management and reintroduction of endangered species. Recently released Swift Foxes (*Vulpes velox*) have been spotted in the park and they will hopefully become permanently established. GNP is the prime area for Black-footed Ferret (*Mustela nigripes*) reintroduction in Canada. Discussions between Saskatchewan, CPS, Canadian Wildlife Service, and United States counterparts will determine when a reintroduction will be attempted.

Another significant achievement worth noting is a Service Bureau contract with the University of Regina. Through this arrangement the Department of Geography will input park data into a Geographic Information System program. The increased analytical and presentation capacity should prove very useful in the upcoming planning programs. More importantly, cooperation forges worthwhile links with the university which should prove mutually beneficial in the future.

Obviously the CPS has been able to meet some of its challenges but others remain to be addressed. Initially the most significant challenge was to acquire land and establish a momentum in creating the park. Although this challenge has been significantly accomplished it will be prominent over the next decade. I believe that the remaining properties may be some of the most difficult to acquire.

The acquisition of land has posed new challenges to the operation at GNP. That is to manage the land acquired, both inside and outside the proposed boundaries. The challenge has numerous dimensions. In spite of 107 years of experience in managing national parks in Canada, CPS has no experience and very limited expertise to manage a grasslands ecosystem. Early investigation show that expertise in managing grasslands in a national park context is equally sparse in other jurisdictions. We are therefore, pioneers in this regard —pioneers trying to re-establish, to the extent possible, what the pioneers to the prairies encountered. We know as we begin that many components of that early ecosystem have been lost forever.

The primary task is to define the essential elements and describe their condition, then we can embark on the task of achieving them. This rather simplistic approach is already beset with hurdles.

There is a fairly well publicized local debate of how grasslands should be maintained. Ranchers, quite predictably, believe that park-acquired lands should be grazed to maintain species diversity. Others proposes the opposite treatment. The answer lies in research.

While most of the land acquired is undisturbed natural prairie, there are also pieces that have been broken. Some land which was abandoned in the 1930s has naturally established itself, some has been seeded with exotic species while some is under active cultivation. Rehabilitation of these areas poses interesting challenges but also provides equally interesting research opportunities.

Of concern, but perhaps out of reach, is the management of the Frenchman River, the central theme of the West Block. The natural flow of this stream has been manipulated since 1937. The result is that every piece of flat ground along the Frenchman has been broken and seeded to high yielding exotic grasses. Much of the riparian habitat has either been destroyed or significantly altered. Manipulation of the Frenchman is certain to continue; not so certain is the implication on the park ecosystem.

Perhaps the greatest challenge of all is to establish a national park in an area far removed from any other national park. In this situation, local residents are not aware and often unsympathetic to the national park concept and management principles. For example, it is a commonly held local view that any grass that is neither grazed nor harvested is wasted. Similarly lost hunting opportunities on park lands are also viewed as wasteful. Some even question the need to protect prairie dogs (*Cynomys* spp.) and rattlesnakes—they don't have any obvious or direct economic benefit. Surely appreciation and support for park principles will grow, but only after concentrated efforts by park staff with support from conservation organizations.

The current economic environment in the world and the attempts by governments to hold the line on spending is frustrating efforts to establish the park. Funding for land purchases is becoming precarious. The credibility of federal/provincial initiatives may be questioned yet another time.

While the challenges may appear formidable, they can be met with the help of those who may be willing to take advantage of the opportunities that are provided. The recent application by The Provincial Museum of Alberta under the Eco-Research, Tri Council Green Plan Program is a prime example of a cooperative endeavour that will provide mutual benefits.

The greatest need exists in the area of long term monitoring of the grassland ecosystem in response to certain treatments. The recently approved Park Conservation Plan is a useful document to identify research needs from a CPS perspective. It can also be used to identify research opportunities for researchers.

Together I am confident we can succeed.

WORLD WILDLIFE FUND CANADA ENDANGERED SPACES CAMPAIGN

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If one looks at calendars or books in which Manitoba is featured, more often than not our province is portrayed by our floral emblem, the Prairie Crocus (*Anemone patens*); or it's a view of a landscape from agro-Manitoba—hay fields cut in swaths ready for baling. This view doesn't change for visitors to our province arriving by air into Winnipeg—they see fields planted with crops of one sort or another.

But there's a different view of Manitoba—one that is shared by naturalists and nature lovers. When they think of Manitoba a very different picture comes to mind..., perhaps it's a memory of a canoe trip taken on a lake in the Canadian Shield, or a hike through Spirit Sands in Spruce Woods Provincial Park. It could be the snakes at Narcisse Snake Pits, or a quinzee in the midst of the Whiteshell Provincial Park. A trip to Oak Hammock Marsh to watch the fall migration is always a favorite, as are the autumn leaves on the Hunt Lake Hiking Trail. For those who venture further afield, there are the spectacular fall colours of the arctic tundra. Big Bluestem (*Andropogon gerardii*), one of the indicator species of tall grass prairie conjures up images of the first settlers winding their way westward. Others think of Elk (*Cervus elaphus*) bugling in the Duck Mountains. Adventurous souls have discovered caving opportunities, and even they contain their own breed of wildlife—Little Brown Bats (*Myotis lucifugus*). Some naturalists think of carving ski trails through untouched snow, while others reflect on a moody Manitoba morning.

These images paint a picture of Manitoba that is indeed unfamiliar to most Canadians and, for that matter, many Manitobans. Our so called prairie province is in reality, a transition zone where eastern forests meet prairie grassland, and rivers flow down off the Canadian Shield to prairie Lake Winnipeg. In fact, lakes and forests comprise 60% of Manitoba's geography. So much for our prairie image.

But there's more to this beauty than meets the eye. Contained in this beauty is a great treasure in which a trained eye sees thriving ecosystems and biological diversity. Biological diversity? Some would say, what do those words mean? Just more jargon to throw my way? Simply stated, biological diversity is the wealth of life on earth, the millions of plants, animals, and micro-organisms, the genes they contain, and the intricate ecosystems they help build into the living environment. One measure of the extent of biological diversity is the number of species in an ecosystem. Let's take an example.

Let's look at a mixed forest on a ridge in Grand Beach. There's a great diversity of tree species in this forest, and on the forest floor, other plant species, like fungi and moss. And all around, the decaying matter and bacteria that helps to recreate the soil from which the trees grow forth. This habitat supports other species of wildlife such as the Ruffed Grouse (*Bonasa umbellus*).

Let's look for a moment at a different forest—a planted or managed forest. This forest is a monoculture, that is, all the trees are of one species. And if you look at the forest floor, you see a lack of understory or non-tree species and perhaps a lack of wildlife as well. This forest is also an example of a second measure of biological diversity, the variety within a particular species. A planted forest of all one type of tree coming from the same seed stock may not have the variety within its species that a naturally reforested area would have.

Today there is great concern about the loss of biodiversity (McNeely et al. no date). The ecosystems created by the interaction of plants, animals, and micro-organisms with the air, water, and soils result in a balance of nature. The loss of diversity may disrupt this balance and the fundamental biological systems and processes upon which all life, including human, depends.

There are other concerns about the loss of biodiversity (World Wildlife Fund [WWF] 1988). From earliest time, people have made use of extracts from plants and animals in the wild for medicines. Our only means of providing strong resistance to disease in our main food crops is by cross-breeding them with resistant strains or wild varieties. Protecting natural areas such as the tall grass prairie ensures the availability of a genetic storehouse or natural pharmacy from which new strains of domestic crops and new medicines can be derived.

Manitoba is relatively young, having emerged from the Ice Age only 12,000 years ago—Churchill, only 5,000 years ago—and our species are still diversifying. We need to protect large areas in their natural state if we are to realize the full potential of this continuing diversification.

The retention of biodiversity, and the continuing adaptation and selection process of the best genetic material are key reasons why we need to protect areas in their natural state. What are other reasons?

Species are the building blocks of ecosystems, and indicators of ecosystem health. We can look to various indicator species in an ecosystem to tell us how part of that system is operating. Protected areas that are allowed to remain in their natural state, form natural laboratories for scientific study, and serve as benchmarks against which we can judge the health of more developed areas.

To save endangered species, such as the Burrowing Owl (*Athene cunicularia*), and prevent others from becoming endangered, we must protect or restore their habitats, our endangered spaces.

Extinctions of plant and animal species are a natural ecological and evolutionary process. Within historical times, however, the rates have accelerated to the point where, in the last decades of the twentieth century, the rate of extinction will be somewhere between 40 and 400 times the rate over geological time. While a number of species protection measures have been effective, such as the Peregrine Falcon (*Falco peregrinus*) Recovery Project in and around Winnipeg, and the Plains Bison (*Bison b. bison*) in Riding Mountain National Park, species are best conserved as parts of larger ecosystems. There they can continue to adapt to changing conditions as part of their respective communities; or withstand natural disasters such as fire. Everything in an ecosystem is interrelated, and we have to provide a large enough area for these interactions to occur naturally, for species to migrate as they have over centuries, and to allow adaptations over time to such things as climate change.

What do we do about this loss of biodiversity and the increase in the endangered species list?

In 1987, the World Commission on Environment and Development issued a report called "Our Common Future". This report recommended that one of the ways to address the loss of biodiversity was to protect representative areas of all the earth's ecosystems free from human development. The report also said that we need to increase the earth's lands and waters that are currently protected from four percent to twelve percent.

In 1989, WWF Canada took up the challenge posed by "Our Common Future" with an ambitious campaign to protect representative areas of the natural regions in Canada, the provinces and territories, such that when all the areas were added up, we'd have protected about 12% of Canada's lands and waters (Hummel 1989). And they set out to do this by the year 2000. They called this ambitious undertaking the Endangered Spaces Campaign (ESC).

From the beginning, the campaign had its work cut out for it. In Canada, after 100 years of conservation work, we had only managed to protect 3.6% of our country's lands and waters, and only half of our national natural regions free from development that severely alter the landscape—development such as logging, mining, and hydro. But let's turn our attention to Manitoba.

Manitoba has twelve natural regions, which have been designated by the provincial Department of Natural Resources. These natural regions have been classified according to their physiography, their vegetation, and climatic zone. Each natural region is representative of a different ecosystem. So the goal of the ESC in Manitoba, is to protect areas in each of these natural regions sufficiently large to adequately represent the area.

This means that we can't circle a huge area in the northern transition zone pictured here and say we've done the job of protecting our lands and waters. We need to have representative areas preserved in each of our natural regions. How do we protect lands and waters in Manitoba?

Most of the areas we will want to protect exist on Crown lands. National and provincial park classifications are one way in which we protect lands and waters that are under the jurisdiction of the Crown.

However, we have normally drawn park boundaries to reflect the spectacular or unusual; borders which reflect considerations other than ecological ones. If we are to use park classification as a means of protecting natural areas, we need to change our thinking and draw boundaries that reflect an image of parks as biological reservoirs, to increasingly emphasize their role as ecological preserves, and to reduce pressures for development that would have a negative impact on the habitat and wildlife within their boundaries.

Other means by which we protect areas in Manitoba include Ecological Reserves (ERs) and Wildlife Management Areas (WMAs). These tools are somewhat lacking, however, in that ERs tend to be very small sites which cannot withstand pressures from outside their boundaries, and WMAs allow human activity within their boundaries that may negatively impact on their ecosystems.

Even our provincial parks have drawbacks. Only one classification—wilderness park—prohibits major resource extraction. In fact, major resource extraction such as mining and logging, continue in most of our provincial parks and even our one wilderness park is open to mineral exploration. To meet the protection requirements of the ESC, we need to strengthen our legislation such that it will protect areas from development for all time.

Let's take a look at Manitoba, and see what kind of job we have done of protecting those lands and waters under jurisdiction of the Crown. Adding up all of the areas to which we have given some kind of protective status—national parks, provincial parks, ERs, and WMAs—we come up with a figure of about 9.7%. Not bad when you compare it to the goal of 12%. If we remove all those areas that have insufficient protection under provincial legislation, and those areas that are inadequate in size, we're left with less than 2%: our one national park: Riding Mountain, Atikaki Provincial Wilderness Park, the Mantario Wilderness Zone in Whiteshell Provincial Park, Hecla Island, and Spruce Woods Heritage Parks—but even these contain major roadways and facilities. Remove these intrusions and you get about 1.2%. About one/tenth of what we'd like to protect under the ESC.

Another dimension to this issue is that only four of our twelve natural regions have areas protected within them. Clearly, we have our job cut out for us. What's going on in these regions that are unrepresented? Do we still have options left to preserve areas within them?

There is still time to save species and their ecosystems but time is running out. Already in Manitoba, we have lost the option to preserve large, roadless wilderness areas in the southern part of the province. Most of this land is privately held and we will have to look at private stewardship to preserve these areas. However, we need to recognize the contribution that private landowners will make to the campaign objectives through tax concessions for land left in its natural state as well as changes in agricultural policies that do not presently encourage landowners to retain land free from cultivation.

We are in danger of losing special areas in northern Manitoba, as more than 60% of our productive forests are included in the licensing areas of two forestry companies. We must identify areas within these license units that should be protected, before the areas are cut. A comprehensive forest policy that includes protected areas is required.

The Seal and Hayes rivers are the last two of our great northern rivers that are undeveloped. The estuaries of these rivers, together with the Nelson and Churchill rivers flow into Hudson Bay and create habitat for Beluga (*Delphinapterus leucas*) that migrate to Hudson Bay each summer. But both the Seal and Hayes rivers are candidates for future hydro development. While we derive great benefit from these hydro projects, we must also be aware of their effects on the Hudson Bay ecosystem. Ontario and Québec are also adding pressure to this eco-system through hydro projects of their own and these combined effects may significantly alter the habitat in the Bay. While the western Hudson Bay population of Beluga is still thriving, those of eastern Hudson Bay, the eastern Arctic, and the St. Lawrence River are on the national endangered species list.

Roads not only cut through the landscape, but they open up areas and allow increased accessibility leading to increased pressures on wildlife that were previously protected by their remote location. Herbicides are used to control growth along their edges destroying plants and insects thus having an effect all the way up the food chain.

I have looked at the areas we have protected in this province. Now I will review those that we have developed or have targeted for development. The combined impacts of hydro, forestry, mining (Zahalan 1980), agriculture, major roads, and railroads, developments and proposed developments will change well over 60% of the province irrevocably and forever.

Clearly there is a need for a more balanced approach; a place for preservation at the decision-making table. And this balanced approach has its other benefits, aside from the preservation of species and biodiversity.

Protected areas provide opportunities for economic diversity such as tourism, particularly in remote wilderness areas where resource extraction has always played a large role in economic development. Wilderness trippers require support services and guides for their travels. Diversification of local economies provides stability, just as diversity in a biological community provides stability.

Where would Tom Thompson, A.Y. Jackson, Emilie Carr, Bill Mason, and our own renowned photographer Robert Taylor be without natural areas, wilderness and wildlife from which to draw their inspiration? Where would we all be without wildlife to look at. Wildlife viewing and photography are two of the fastest growing industries in North America. Until this last year, bird watching was the biggest sport in North America.

Most justifications for the preservation of wilderness and natural landscapes are based on economic and utilitarian arguments—just as the ones I've given here. But what about nature for the sake of nature. John Livingston, writing in *Endangered Spaces: The Future for Canada's Wilderness* (Hummel 1989), says that "any attempt to make a case for a park other than the human one is difficult. We cannot prove (nature) out by cold logic or numbers. But as every naturalist knows, nature is not rational or logical." Surrounded by nature, we experience a profound sense of well-being and joy—the fresh smell after a spring rain, the rustling of leaves in the wind, the haunting cry of the loon.... Retaining natural areas ensures that there are places for us to go when we seek spiritual renewal and rejuvenation.

Wilderness speaks to the heart of all of us and binds us together as Canadians. It's part of our psyche and helps define us as a nation. Can we imagine Canada without wilderness?

Canada's aboriginal peoples hold deep and direct ties to wilderness areas throughout Canada and seek to maintain traditional wilderness use. *Our Common Future* asserts that aboriginal peoples have the right to be involved in planning and decision-making regarding natural resources (World Commission on Environment and Development 1987).

In summary, wilderness sustains a range of values including aesthetic, cultural, spiritual, economic, scientific, and therapeutic. But as visionary Aldo Leopold (1949, page 199) said, "Wilderness is a resource which can shrink but not grow. Invasions can be arrested or modified in a manner to keep an area useable either for recreation, or for science, or for wildlife, but the creation of new wilderness in the full sense of the word is impossible."

Our Common Future says that the preservation of representative areas of our ecosystems "is an indispensable prerequisite for sustainable development. Our failure to do so will not be forgiven by future generations" (ibid., page 166). This means that preservation has to become part of the thinking and decision-making process in all our developments and land use in Manitoba and has to be done first before we foreclose our options. Once developed it's gone, but if protected, all our options, whether they be for continued protection or for development, are still wide open.

Are we listening? Well, I think so. At the time of the provincial election in September 1990, Premier Filmon committed to completing the agenda set out by the ESC becoming the first province in Canada to do so. Since then, Manitoba has been joined in its commitment by all other provinces and territories except New Brunswick, Québec, and Alberta. The Federal government has also committed to doing its part by completing its national terrestrial parks system by the year 2000.

Quoting from Premier Filmon's words spoken at the launch of the ESC in Manitoba in February of 1990: "Sustainable development is a grass-roots concept. It depends on the active involvement and participation by all citizens to find solutions to problems, to identify opportunities and to mold the type of society that will meet our needs and those of future generations. The concept of maintaining wilderness into the future is both a source of inspiration and challenge. There is still much work to be done."

Protecting lands through official designation is one thing, but what can we as individuals do?

Join the over 415,000 Canadians who have signed the Canadian Wilderness Charter which sets out the goals and vision of the ESC. Get others to sign the charter.

Join or support an environmental organization that is working actively to support the campaign, such as the Manitoba Naturalists Society and get involved as an active volunteer.

Get and read a copy of the book *Endangered Spaces: The Future for Canada's Wilderness* (Hummel 1989) or make a donation to the ESC to ensure that its message continues to be heard across Manitoba.

Be a prairie patron and buy an honourary deed to an acre of tall grass prairie. Help create the Tall Grass Prairie Preserve in southeastern Manitoba or nominate an area that you think should be protected.

The task ahead of protecting natural areas is one that will take much effort, collaboration, and cooperation. It will take the education and involvement of each and every one of us. It will take understanding the impacts, on local residents, of protecting lands and waters. It will take understanding the impacts on industry and finding new ways of doing business—together. It is a task that will take commitment and a collective will to see it through. I believe this will exists; after all, can we accept Canada and Canadian life without wilderness?

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THE NEED FOR COOPERATION ON PRAIRIE CONSERVATION

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I'm not sure that Garry Trottier's introduction of me as a hunter makes me feel all that comfortable in this crowd dominated by naturalists! But I don't make any distinction between hunters and naturalists since we are all conservationists, so I guess I don't have to worry.

I want to focus today not so much on specific techniques but on the fundamental approaches to prairie conservation. Lets try to "see the forest for the trees." Our Saskatchewan programs and experience won't be specifically mentioned but will be reflected in what I have to say.

I want to talk about the two camps we're dealing with here: 1) agriculturalists (including farmers/ranchers); 2) conservationists (including hunters and naturalists). I include associated agencies and organization in these groups.

What is the background relationship between these two groups? There isn't one, at least nothing to speak of! There's been very little communication and cooperation between them. There is Ducks Unlimited's long history of working on private land. And there are some other fledging efforts to work together, notably under the North American Waterfowl Management Plan. But basically this has been a black and white situation. We've gone our way and they've gone theirs. That's got to change! Some underlying things have to change first, notably respect and recognition for one another.

As conservationists, we need to show more respect for the men and women on the land. Most of them do love the land. It may take a little different form from our love of the land—but it's love nonetheless.

Secondly, we must recognize that they, the grain farmers, are in a desperate economic situation. Nobody is making money these days, not even the best of farmers! They're just hanging on by the skin of their teeth and with considerable help from us through government support programs or "handouts." There are a lot of jokes and cynicism about this support, but would we have a century old industry, complete with hundreds of thousands of people, go down the drain virtually over night? I don't think so! And we have to take an understanding view of land use practises, including the practise of cultivating every square inch that is possible. Intense cultivation has been heavily encouraged by our society through government agriculture policies and programs. Is the farmer liable to leave much native habitat if the only way he can market grain or qualify for support payments is on a cultivated acreage basis? Not bloody likely!

So I think we have to have a little sympathy for farmers. Maybe this is just my farmer roots showing through! I gladly confess to having those. But what I've just said is fact, as far as I can determine.

By now you may think I view the farming community as above reproach, as white knights in shining armour who just happened to have fallen off their horse and need a bit of help to get back on? Not really! Their armour is pretty tarnished, even rusted through in places.

Farmers need to recognize their industry depends on the health of the environment and that other animals and people share that environment. Their attitudes are a reflection of 100 years of subjugating nature in this part of the world. This has to change. We all, including farmers, have to start working with nature and living in harmony with it. They must realize that the productivity they've experienced has been on the back of virgin prairie soils and that the gravy train is coming to an end.

Farmers also must recognize that Canadian society and their governments are soon going to be wanting more bang for their buck. They're going to be wanting some environmental return for the farm support dollars.

So were do we go in the future?

Well, what we really need is a lot more communication and cooperation! There's far too little of this between the farmer and conservationist camps (and in the world in general) these days. Things are also conspiring to force us to cooperate, just as they did in the early history of prairie farming (i.e., the "bees"). This culminated in the formation of major cooperative institutions during the real tough times of the "dirty '30s." I'm talking about things like the Wheat Pool and the Canadian Commonwealth Federation party, of course. There are a lot of similarities between that period and today, notably, a lack of resources. But what are the responsibilities of, first of all, the agriculture camp?

Farmers must show more responsibility for soil and water conservation. Wildlife habitat conservation goes hand in hand with this, as we know. Specific attention to wildlife habitat is also appropriate. Do what you can afford to do for wildlife, should be the message to farmers. They should also take responsibility for working with conservationists on mutual interests.

Conservationists must start communicating with the farming community. As Cool Hand Luke said in that famous movie "what we have here is a failure to communicate!" My apologies to our American guests for the attempted United States accent! We must start giving them information about ecological relationships and how to conserve wildlife, not telling them what to do.

We must also embrace the principle of private stewardship. We haven't always done that up to now—myself included. The vast majority of land on the prairies is privately owned (or controlled) and will remain so. The World Wildlife Fund (WWF) is showing leadership in this area through their enlightened land tenure criteria for protected areas.

We also have to be real careful about the position we take on land use. I'm sure glad I checked with Monte Hummel yesterday on the WWF position on this before I got up here today! I was all ready to blast them for what I understood their position to be on grazing and petroleum development, namely that they were outright opposed to it. He assured me that wasn't the case—that they were not opposed to it and looked at every case on it's merits. That's good, because it isn't realistic to expect to reach the admirable endangered spaces goal in the grassland without living with these land uses. But equally pertinent, they do not necessarily have a significant negative impact on natural areas. We have to recognize there aren't going to be any more grassland national parks (I will bet). It's going to be a jewel, but we can't hope to accomplish all our conservation goals through park creation. It just isn't going to happen! Similarly, outfits like my department are going to have difficulty expanding other parks and we're not going to be able to buy everything either. We have to look for other ways. Private stewardship is one of those ways, and joint ventures with agricultural organizations and agencies is increasingly a possibility.

I see private stewardship taking various forms from landowners doing their own thing on one end of the spectrum to nongovernment organizations (NGOs) buying land with private funds, and everything in between. This must largely be driven by information. We've got to be prepared to invest some serious dollars in this! It may seem like a waste of money to advertise etc. but it's probably the most cost-effective in the long run. There's an especially great potential to apply private stewardship to the "sexy" endangered species!

But we can't "throw the baby out with the bathwater." We have to maintain the important initiatives on Crown land. Nature conservation must be formally recognized as a legitimate use of some of our Crown lands, mostly as one of several compatible uses of the same piece of land. Legislation is the best way to go—it's much more permanent than a policy decision, which literally can be changed with the stroke of a pen! You just have to be prepared for the long haul, including the backroom lobbying, to get such legislation as the Saskatchewan Critical Wildlife Habitat Protection Act. Unfortunately, traditional Crown land users perceive this as the "stick" approach and I don't know how to get around that. It has to do with fundamental differences in philosophy concerning the public versus the private domain.

Purchase programs will probably have to be deemphasized, although it will hurt us to do it. Hopefully, we can always maintain the ability to do this on a selective basis. Sometimes there is just no substitute! But we'll have to put a lot of money elsewhere. Within this program, we should also divert some resources from purchase budgets to better, cooperative management of the lands we now control. This is for two reasons to: 1) get better management and public use of the holdings; and 2) ensure that they stay in our possession; a sense of ownership by the public will stand you in much better stead when the chips are down than the piece of paper which is the title.

And finally, for the biggy, which we have to do in cooperation with agriculture. All of society has to share this baby!

I'm talking about reform of agricultural programs and policies, of course. This will do more for nature conservation than everything else combined! We in the conservation field don't have control of the agenda here but I believe that the environmental concern is strong enough in this country that we can presume to have an influence, perhaps a pivotal one. How do we do that?

Well, you've probably got just as many good ideas as I have, but I will offer a couple of general thoughts.

While respecting the importance of agriculture and the people in it, we shouldn't be intimidated by it any more. As the saying goes "they put their pants on in the morning the same way we do." And they're opening up to environmental concerns. Witness the recent navel gazing the federal and provincial Ministers of Agriculture did, culminating in the adoption as policy, of the very progressive document called Growing Together (Federal-Provincial Agriculture Committee on Environmental Sustainability 1990).

And lastly, let's do something, don't just talk about it. I'm reminded here about the poster showing two vultures sitting in a tree looking out over the desert. One says to the other "Patience my ass, I want to kill something!" I identify with that vulture! The studies have been done (i.e., Girt 1990); the negative relationships are pretty well known. We now have to work to effect change using the tools and the avenues available to us. Bureaucrats like me have to get with it within our circles and the NGOs and private citizens have to exert their considerable influence. We both have our power.

Well, I hope I've been fair in my comments today. I also hope they provoke a little discussion and thought. I'd like to reiterate my thoughts here today that what we need more of is cooperation in the prairie conservation arena. With more of that all around, the present opportunities will be maximized.

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RURAL MUNICIPAL CONSERVATION - WORKING WITH MUNICIPALITIES IN DELIVERING CONSERVATION PROGRAMS

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It is my experience that if any agency wants to succeed in delivering a conservation program in prairie Canada, that agency must deal in good faith with the rural municipal (RM) or local government district (LGD) council representing the ratepayers of that particular land base.

Having said that, conservation program delivery agencies in general, and some wildlife agencies in particular, have been slow to recognize this fact. In our enthusiasm and zeal to get conservation program elements on the landscape, delivery agencies have often bypassed the local municipal government in favour of dealing directly with the landowner.

In Manitoba, this has caused serious problems, particularly prior to the 1980s, when lands purchased by the Crown for wildlife designation were exempt from municipal taxes and consequently were lost to the municipality as a tax base. Obviously this was of concern to local governments. Currently, the Manitoba government pays the appropriate municipality a grant in lieu of taxes on any Crown Land designated for wildlife management purposes.

It is not always easy to obtain support of local governments for conservation programs. Here are obstacles you may encounter when you solicit the support of the local municipal council for delivery of a conservation program in that RM or LGD.

Some RM's have had bitter experiences with former programs and view new initiatives with a jaundiced eye. (They don't buy the line "We are from the government and we are here to help you.") Problems with wildlife damage to farm crops, bad experiences with other government agencies and representatives, and municipal assessment problems are just a few of the examples that I have encountered.

We must recognize that councils are extremely busy and are under a great deal of pressure. They are besieged by delegations concerned about problems with local social and physical infrastructure and are under constant pressure to provide services within a reasonable tax levy. The challenge of maintaining the education system, roads, health care, and a wide range of other services is uppermost in the minds of most councillors. Therefore, it is not uncommon for councils to give short shrift to agency representatives that appear before them peddling one sort of conservation program or the other. This is particularly true if the program doesn't appear to be friendly to agriculture or, in fact, appears to infringe upon the producer's income and therefore the tax base of the municipality.

Councillors are only human and that is sometimes reflected when they allow very strong personal biases against a program or the delivery agency to colour their judgement when, in fact, that program may have significant value for the producers and their land. For example, a councillor may have been a victim of duck damage so he may take a dim view of programs to produce more ducks.

There have been, and are, situations (although rare) whereby a municipal council does not represent the ratepayers when it condemns a particular conservation initiative. Conversely, municipal councils are sometimes much more progressive in their thinking than the folks they represent. This may inadvertently lead you to believe that their ratepayers will welcome you when you call but, in fact, they may be very cool to your proposals. I bring these points to your attention lest some of you are left with the impression that to work with and secure the approval of a municipality all you have to do is simply "waltz" in with your flip charts, overhead slides, and nice coloured maps and expect the local council to welcome you with open arms.

Perhaps the best way to secure the approval of a municipal council for your conservation project is to develop and/or solicit the support of local residents or organizations as an advocate. For example, when the Manitoba Wildlife Branch promoted the protection of undeveloped road allowances by urging municipal councils to pass bylaws prohibiting destruction of these ribbons of habitat, it was the dedication of the local Conservation Districts and wildlife associations that helped to persuade those councils that passed and supported such a bylaw.

Wildlife program managers in Manitoba have had excellent success in using local advisory committees to bridge the gap between local municipal governments and the agencies delivering the conservation program. The Manitoba experience comes from various large habitat initiatives such as Heritage Marsh projects and the Habitat Enhancement Land Use Program (HELP) in the RM of Shoal Lake. Our most recent experience with local advisory committees is related to the coordination and delivery of the North American Waterfowl Management Plan. In 1991, the Manitoba Habitat Heritage Corporation invited 10 to 12 producers in each of our four program delivery areas to sit on a local Liaison Committee in their respective areas. At least one of these individuals is a municipal councillor from the local community. These four advisory committees provide a means for information exchange and feedback among program delivery people and local communities. In my opinion, that type of local input is a prerequisite for the successful delivery of conservation programs on private land in prairie Canada.

An important element in the acceptance and support of the local RM for a conservation program is to place your field delivery staff in the local community. This may cause an increase in your start-up costs but it will pay big dividends in the success of your program.

Once you have received the blessing of the local RM for your project, how do you maintain that support? Here are a few suggestions.

It is important to provide regular program updates to the local municipal council in person because you cannot always rely upon the council's representative on your local advisory committee to do an adequate job. You should also realize that councils sometimes lose touch with their ratepayers so don't assume that approval of the local advisory committee automatically means approval of the local municipal council.

Keep in mind that municipal councillors are politicians and a very key component to our democratic form of government. Therefore, as your conservation program gains momentum and builds support in the community, make sure the municipal council gets some of the credit. Landowner appreciation barbecues, fowl suppers, and project dedications are excellent means of giving recognition to municipal officials. Ducks Unlimited Canada has successfully used project dedications to this end and the Delta Waterfowl Research Station, for years, has hosted a landowner appreciation barbecue for Minnedosa area farmer-cooperators in Manitoba.

In closing, I reiterate that the support and guidance of the municipal government in your project area is virtually a prerequisite if you hope to be successful in any long-term conservation initiative in prairie Canada. And the key to the support of the local council is honest and frequent communication in plain language.

LAND MANAGEMENT: A PERSONAL VIEW

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The area that I am from in south-central Saskatchewan was first settled by ranchers in the 1880s. In the winter of 1906/1907, 80% of the cattle on the open ranges died of starvation or exposure. This was the end of the large company ranches on the open range. The prairie lands were opened up for homesteading and soon we had large numbers of people breaking up vast acres of mature prairie land. Much of this land was not suitable for farming and many of the homesteaders were not equipped or prepared for the pioneering hard times that lay ahead. The drought and the depression of the 1930s caused an ever increasing exodus of farm families.

In the 1930s the government, through agencies such as Prairie Farm Rehabilitation Administration, started rehabilitating some of the blown-out land. Through the use of Crested Wheat Grass (*Agropyron cristatum*) and other plants, community pastures (both federal and provincial) were organized. This encouraged the production of livestock, mostly cattle. In the 1930s it was discovered that the family rancher or the mixed farmer was better able to cope with the economic and drought conditions of the times and since then, southern Saskatchewan has had a fairly strong, viable cattle industry. With proper usage and management, the Palliser triangle area has proven to be a good agricultural production area for both grains and livestock.

On a personal basis, I was the fourth child of 12 born to a ranching family in the Wood Mountain area. In 1937, the driest year of the 1930s, commodity prices dropped to an all-time low. Cattle were selling for as little as 1¢ per pound. It was this year (1937), at the age of 17, that I bought my first quarter of land. The price was $150 and I also purchased 60 head of sheep at 5¢ per head. I borrowed the money from a dentist uncle in Turva, United States with interest at 6%. Two years later I traded 10 horses for a contract on some provincial government range land. This pasture land is within the core area of the east block of the Grasslands National Park (GNP).

From this modest start in the 1930s in partnership with my youngest son, we have built up our ranch to 31 sections (19,800 acres). Of these 31 sections, 20 are Crown land leased from the Government of Saskatchewan and 11 are deeded land. The eleven sections of deeded land (7,040 acres) are a mixture of agricultural farm lands and mature pasture land. We farm 1860 acres on a half and half summer fallow basis, with 800 acres of farm land seeded to pasture and hay and the remaining 2660 acres left in its native pasture state. Our holdings are divided in two ranches of equal size. One is located near the east block of GNP and the other is 90 miles east in the Big Muddy Valley between Minton and Big Beaver.

Now what about wildlife. In the 1930s we had Pronghorn Antelope (*Antilocapra americana*) in good numbers, Sage Grouse (*Centrocercus urophasianus*), Greater Prairie Chickens (*Tympanuchus cupido*), a few Gray Partridges (*Perdix perdix*), some ducks on the creeks, and a few deer. Since the 1930s deer and antelope have increased, Sage Grouse and Greater Prairie Chickens are fewer in number, and now, along with the Gray Partridge, we also have Ring-necked Pheasants (*Phasianus colchicus*), and we still have Burrowing Owls (*Athene cunicularia*).

Hunting seasons for much of the wild game started in the 1950s, and since then antelope have extended their range to the farming communities near Moose Jaw and Weyburn. The deer population (both Mule Deer [*Odocoileus hemionus*] and White-tailed Deer [*O. virginianus*]) have increased most dramatically, and in many instances the deer have caused much damage to rancher's feed supplies. At the present time, we are providing the grass shelter and habitat for at least 300 antelope and 150 deer, and protection for Sage Grouse, Sharp-tailed Grouse, Gray Partridge, and Ring-necked Pheasant. We are providing a living and safety for these animals because we have the native grasslands with the natural protection of the coulees, the trees, and the brush.

At the present time, the laws in Saskatchewan give us control of access to our lands. We don't care to hunt, we like our animals, but on the other hand we recognize that wildlife must be managed and harvested just like our cattle and sheep. Other than in the immediate area around our home ranch, we have always allowed hunting, mostly on a first come-first served basis. The majority of the hunters are good, however, once the hunting season starts in September, we live in fear of gates being left open and are even more fearful of a prairie fire caused by the hunters. We have also cooperated with people who want to picnic, hike, take pictures, or have trail rides or wagon trains. All we ask is respect for our property and grasslands. All tourists should keep in mind that the rancher's grass is the rancher's livelihood. What annoys me are hunters who will post their own land and then come and move freely over ours.

In Saskatchewan, we have had government programs that have paid for feed damage caused by deer, supplied material for fences, and provided feed for the deer. Many of these programs have now been suspended and there is more flexibility in the hunting of the deer that are causing the problem. Some of the above programs have probably been abused, if not abused they have been used more by some ranchers than by others. It doesn't seem right that a land owner can post his land (no hunting) and then collect damages for feed eaten by the deer.

Relationships between land owners and hunters are not the best. Much of our area is posted "no hunting" or "hunting with permission only." What are the answers to the present friction? I'm not sure, but it seems to me that all persons involved, including nature lovers, environmentalists, hunters, and government, have to realize that the land owner, who has kept some land in its native state, is the one who is protecting the wildlife and the plants and somehow these persons are entitled to some compensation. With the large four wheel drive tractors, very little of this native land is safe from being turned into grain production.

I recognize the fact that the animals were here before I was and therefore, I should have some responsibility to their keep. However, if as a result of climatic factors or government programs, the animals increase to unreasonable numbers, then it seems reasonable to me that I should be entitled to some compensation. If better cooperation is not achieved between hunters and land owners I can see more and more land being posted.

An extreme situation developed recently in Montana when Ted Turner of CNTV Atlanta bought a large range in a good hunting area. Mr. Turner immediately imposed a no trespassing and no hunting policy. The hunting fraternity of the area complained. Mr. Turner organized a public meeting and he told them that if they wanted to hunt they should buy their own land.

It seems to me that landowners in the settled areas of Saskatchewan are the ones who preserve the animals. Perhaps compensation could be paid on an acreage or assessment basis.

Now let us examine some other government programs. The person who has retained land in its native state or who has seeded cultivated acreage back to grass has been discriminated against by government programs. For many years the subsidized support programs have been calculated and paid mostly on the basis of bushels sold or on the basis of acreage seeded. The person who looked after his sub-marginal land has lost out on many of these payments. Over the years, the largest subsidy has been on the freight of grains for export or feed freight assistance through the Crow Rate and other payments. This has encouraged the breaking up and increased seeding of grains for export. Government should retain ownership of a lot of this native grassland. However, selling to farmers and ranchers is also a good idea to give the rancher some continuity. On average, I believe most ranchers are good responsible landowners; sometimes they will over-graze in difficult economic times. The government has a responsibility to see that we do abide by our contracts.

Regarding the GNP, I believe the policy of the park in regard to land acquisition has been fair, equitable, and reasonable. Those of us in the GNP area have been going through a lot of uncertainty for 30 years. Now the direction seems to have been established and, on the whole, I'm satisfied with what I've observed so far. The land acquisition will eventually come to a successful conclusion. Some of the problem areas will be wildlife and agitation for grazing privileges. I believe some grazing of livestock should be allowed. I believe cattle within the park will make it a nicer park for the tourists to visit and would also help maintain the viability of some of our local communities. However, I also believe this grazing (if allowed) should be on a well controlled basis. It is my belief that governments (parks), ranchers, cattle, and people (tourists) can get along and each can give and add something to the environment.

PUBLIC LAND MANAGEMENT APPROACHES FOR CONSERVING NATIVE PRAIRIE ENVIRONMENTS - SOME ALBERTA EXAMPLES

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As the agency responsible for the use, management, and administration of provincial Crown lands, Alberta Forestry, Lands and Wildlife is currently using a variety of approaches to conserve native prairie environments. In fact, in prairie and parkland Alberta the management, planning, and coordination resources of the department are increasingly being focused on this task. That may seem odd, especially if one holds a stereotypical image of this kind of agency as being one preoccupied with harvesting fibre from our forests, drawing Animal Unit-Months from our public native grasslands, and managing wildlife to yield game. In fact, the single sectoral approaches to resource allocation and management are increasingly viewed as dated by the public, by resource managers, and yes, even by politicians. This does not mean that such functions are in any way "on the way out," but it does mean that they must take place within a broader integrated context that recognizes other resource uses and values.

The Department of Forestry, Lands and Wildlife, like many agencies, has recently undergone a strategic exercise and our new mission statement (1991) is as follows: "As stewards of Alberta's fish, wildlife, forest and public lands our mission is to manage for sustainability, the integrated use of resources and a healthy environment in harmony with the need of Albertans."

This kind of statement signals a growing maturity in the way in which our common property resources are viewed. Specifically, our staff recognizes:

1. That provincial Crown lands and the multifarious resources that they sustain are a public resource, held in trust for Albertans.

2. That lands should be used and that rights to the use of public lands and resources may be allocated subject to conditions.

3. That public lands with significant multiple resource values such as recreation, habitat, conservation, and wetland values should be managed to retain those values.

4. That the department has a stewardship responsibility to ensure that public lands are managed in a manner that does not impair their sustainability and value to future generations.

5. That environmentally sensitive and significant lands deserve particular attention because: these lands are typically "vulnerable" to other resource uses; native grass prairie ecosystems are a non renewable resource; these lands constitute a small proportion of a landscape dominated by agricultural and cultural uses; and society's interest in the wise and responsible stewardship of our environmental resources is growing.

Our record is by no means perfect, but I think that the department is genuinely espousing a progressive ethic and is trying to balance effectively competing values for resource use in a way that is fair to disposition holders, to long-term public trust obligations and to the environmental imperatives of our time. The approaches currently being used to conserve our native prairie environments provide a good illustration of the way these responsibilities are being discharged.

The number of tools potentially available to achieve conservation objectives on public lands is large and growing. The major impediment to effective action across the board is not a lack of mechanisms or ideas, but rather resources—specifically funding for programs and manpower.

I'd like to provide a brief overview of a variety of tools that we're using together with an assessment of their effectiveness and limitations.

DESIGNATED PROTECTION

Designated protection is an obvious tool, but perhaps the most limited. The advantages of this kind of approach is that nature conservation values are designated as the highest and best use of the site. Through a combination of legislation and/or management plans other resource uses are carefully controlled to ensure that the primary values are not impaired. This generally works satisfactorily although, depending on the kind of site and its location, recreation uses frequently become the dominant priority. The main problems are as follows: 1) in settled Alberta, designated areas—with a couple of significant exceptions—tend to be small and fragmented and when we need to manage native prairie environments on an ecosystem basis, the ecosite approach (areas of 0.25 km^2 or larger) is inherently limiting; 2) the process of designation, public involvement, and management planning is extremely time and resource consumptive; 3) designated sites reinforce some polarized attitudes; they tend to be unpopular and perceived as a threat by many rural residents and once established they can make it more difficult to achieve environmental objectives on other lands—the "we've done our societal duty by protecting site X, and now leave us alone on the rest" syndrome; 4) they may protect key areas, but they often don't protect much; outside of the Eastern Slopes Forest Reserve, all of the designated lands in Alberta's central and southern administrative regions (which basically equate with prairie and parkland Alberta) constitute about 3.5% of all public land and only 0.7% of all land; note that these figures include provincial parks and provincial recreation areas, many of which are recreation sites with limited nature conservation value.

RESERVATION SYSTEM

The department operates a program that allows interested parties (usually a government agency), to register an interest against public land in the records of the department in the form of a "reservation/notation." The registration identifies public land and resources required to achieve particular land use or conservation objectives.

An interesting project is underway in our southern region to place protective and consultative notations on some key environmentally significant and sensitive public lands that are susceptible to surface disturbance and that currently lack adequate protection. Activities by the oil and gas industry in a couple of sensitive areas prompted the project. The intent is a stop gap measure to ensure that key sites are not lost between now and the time that comprehensive land use plans can be put in place. A total of 10 sites encompassing 1990 km^2 (777 mi^2) are being studied by Fish and Wildlife and Public Lands field staff. The placement of appropriate reservations on these sites involves a negotiated process with other interested agencies such as Alberta Energy and the Energy Resources Conservation Board. The amount of land within each study area on which reservations end up being placed ranges from 20-80% based on recent cases. The sites being considered include: 1) key sandhills, badlands, and unique areas which are significant for wildlife and are unique in elevation, topography, aesthetic qualities, etc. and where mitigation or reclamation is extremely difficult; 2) key wildlife breeding/rearing areas such as sage grouse dancing grounds and adjacent nesting areas, breeding sites for threatened wildlife, or rare species; and 3) sites with rare and endangered plant species on them.

The advantages of this mechanism is that it can be put in place fairly quickly and can cover a lot of land. Limitations include the fact that it is not comprehensive, is not permanent (reservations have to be renewed), and cannot be used with liberal abandon. The total number of reservations on public lands has actually decreased in recent years since too many agencies were using the system to "tie up" public lands with insufficient justification.

LAND ACQUISITION

Periodically, highly sensitive private lands are offered for sale to the department. An evaluation of the available sites is conducted with purchases focusing on those lands with major conservation concerns such as highly erodible areas, fragile slope areas, and important watershed management areas. Sites acquired are protected using the reservation system or may be acquired as candidates for formal protection through the Natural Areas Program.

A typical example of this kind of acquisition was last year's purchase of a 132 acre parcel of land along the Oldman River near Picture Butte. The parcel comprises mixed grass upland, fragile river breaks, and river floodplain having high wildlife value in an intensively developed agricultural area.

This kind of tool can be of great value in acquiring specific sites with extremely high environmental values that would otherwise likely be lost. Overall, however, it suffers from the same kinds of limitations associated with designated protection, but to an even greater degree—the amount of total land protected is extremely small. Also, this kind of approach is extremely susceptible in a period of fiscal restraint as Table 1 demonstrates.

Table 1. Funding for land acquisition programs.

	Conservation Land Assembly	Natural Areas Land Acquisition
1990-1991	$225,000	$310,000
1991-1992	$135,000	$200,000
1992-1993 (requested)	$120,000	$170,000

ENVIRONMENTALLY SIGNIFICANT AREAS (ESA) PROTOCOLS

Over the past several years ESA inventories have been undertaken for the vast majority of rural municipalities in prairie and parkland Alberta. These reports provide a reconnaissance level inventory of environmentally significant and sensitive areas—evaluating and classifying the relative sensitivity and significance of the areas identified as to their regional, provincial, and national importance.

A major limitation of these studies is that they are just inventories—while they do identify some management guidelines, these are merely the suggestions of the private consultant. There are two notable efforts underway, however, to facilitate the process of using the information in the reports to achieve conservation objectives on the ground as follows.

Planning Cooperation on Public/Private Lands

Alberta Forestry, Lands and Wildlife has negotiated directly with two regional planning commissions to seek common understandings on the way in which the reports will be used on both public and private lands and to identify areas where cooperative action is required. Areas in which "protocols" have been agreed upon include the use of the reports in both statutory (private) and policy (public) land planning programs, extension activities, cooperation with other jurisdictions, land trading, and cooperative planning.

Maintaining Wildlife and Habitat in Municipalities

The Prairie Conservation Coordinating Committee has struck a work group to follow up on a Prairie Conservation Action Plan (PCAP) recommendation that regional and municipal planning commissions should set objectives to protect wildlife and wildlife habitat on lands within their jurisdiction. The first step was the production of ESA inventories. Now that that task is largely completed, the work group is charged with the task of making recommendations about how these reports should be used to achieve habitat conservation objectives. The work group includes representatives of every regional planning commission in prairie and parkland Alberta. The chairperson has already identified for, discussion purposes, a "Hierarchy of Implementation Tools for the Protection of Environmentally Significant Areas." These include such volunteer measures as extension pamphlets, voluntary stewardship, stewardship enhancement tools (e.g., award programs), written agreements, and conservation easements as well as more regulatory approaches such as designation of an ESA through statutory planning exercises with various requirements (i.e., Environmental Impact Assessment).

These kinds of approaches have their limitations, notably in that they require a major resourcing effort at a time when resources are limited, in that there are a variety of viewpoints as to the most appropriate way to proceed, in that there are a lot of parties and interests involved, and in that the concrete use to which the ESA inventories can be put to in many situations is limited by their very broad, reconnaissance level nature. At the same time the potential rewards are enormous because until recently the number of tools available to achieve substantial environmental protection objectives on private lands has been most limited.

PUBLIC LAND USE PLANNING

Alberta Forestry, Lands and Wildlife coordinates an interdepartmental integrated resource planning (IRP) program which produces plans at regional, subregional, and local levels of analysis. Regionally-conducted land use planning exercises, "regionally integrated decisions" (RIDs) are also undertaken on an as-needed basis. Both kinds of plans are drafted by interdepartmental planning teams according to integrated resource management principles that require a holistic perspective on resource use issues, shared decision-making, and much cooperation, consultation, communication, and coordination. Meaningful public involvement is an essential ingredient of the process and the final plans go through an extensive review and approvals process usually culminating in ministerial or cabinet approval. These plans are policy documents that provide direction for the use, allocation, and management of provincial Crown lands and resources.

Historically, planning attention within the department has focused on those parts of the province where most of the public land is—the Eastern Slopes and boreal Alberta. There are now a number of plans at various stages of development, however, underway in prairie and parkland Alberta as follows.

Regional Plans

Broad strategic plans that focus on the coordination of government policy and resolution of regional policy issues. The regional plan for central Alberta has been publicly reviewed and is in final review and approvals. The draft regional plan for southern Alberta is being finalized by the planning team prior to public review. Both plans provide a description of ecological conditions and set goals, targets, objectives, and guidelines for fisheries and wildlife and ecological resources. The objectives of the PCAP are stated and reinforced.

Sub-Regional

An IRP is currently under development for the Plains Eastern Irrigation District which contains almost 600,000 acres of native mixed grass prairie. The planning team is part way toward developing a draft plan and is proposing a modified zoning scheme with the following three categories.

Protection Management Emphasis Area

Emphasis is on the protection of significant, sensitive, or unique landscapes and their associated flora, fauna, and natural processes.

Conservation Management Emphasis Area

Emphasis is on the conservation of the native mixed grass prairie ecosystem, improved grasslands, and wetlands.

Development Management Emphasis Area (MEA)

Emphasis is on the use of land and resources for development purposes (i.e., to permit activities that are not compatible with the Protection or Conservation MEAs).

An IRP will be initiated in the next few months for the Red Deer River Corridor in central Alberta. This will encompass some 600 km (375 mi) of river corridor with provincially significant historical, ecological, palaeontological, fisheries, wildlife, recreation, tourism, and agricultural values. Ecological resource considerations will be a major subject to be addressed throughout, but especially in the lower Red Deer River between Dinosaur Provincial Park and the Saskatchewan boundary.

Rumsey RID

In 1990, Alberta established a 13 quarter section Ecological Reserve in the Rumsey parkland area. Immediately south of the Ecological Reserve is a 50 section block of public land—Rumsey Parkland South. Together with the ecological reserve, this constitutes the largest remaining block of aspen parkland in the world. Ongoing oil and gas activity in the Rumsey Parkland South area was a concern to environmental groups who would prefer to see designated protection for the entire parkland area. The RID was prepared to ensure that this unique ecosystem is maintained while continuing to allow for the responsible use of the area's resources. The draft plan has been publicly reviewed and is currently being revised by the planning team in light of the public feedback.

In my personal opinion these kinds of resource planning exercises can yield the greatest potential benefits toward maintaining viable native prairie ecosystems on public lands. This is because they cover all of the public land base, at various levels of analysis, and establish resource allocation and use priorities as to "who gets what where" in a holistic manner. Moreover, if the process is fair and seen to be fair, the chances of a liveable outcome that meets environmental, social, and political objectives is vastly increased. Critics of this kind of tool can argue that these plans are policy, rather than statutory documents and that the level of decision making, even at local levels of analysis, can often avoid clear priorities and leave too many options open. Also, this kind of consensual, trade-off approach is not attractive to those who have an "all or nothing" agenda.

TAX RECOVERY LANDS

Alberta Forestry, Lands and Wildlife has administrative control of some 200,000 acres of tax recovery lands. These are private lands repossessed by the province for failure to pay taxes during the depression years. Most of the tax recovery lands were transferred to the administration of the Public Lands Division during the 1930s and were subsequently disposed under long term grazing leases. Tax recovery lands remain technically deed. While tax recovery lands are under lease, Public Lands has administrative control, but at lease renewal time, or if the lessee consents to withdrawals, jurisdiction reverts on request to the local authority. In many instances, tax recovery lands lie within large blocks of Crown grazing leases, or have substantial wildlife or environmental values, making their retention in public ownership desirable. Some local authorities have been pursuing the sales of tax recovery lands for some time.

From the perspective of the department, this raises several issues: 1) there are a lot of tax recovery lands in the Southern Region having multiple use values; 2) tax recovery lands are gradually reverting to local authority control and are being sold; 3) the opportunity to acquire tax recovery lands with significant multiple use values as public land is gradually being lost; and 4) public lands with high multiple use values are at premium in the Southern Region; these lands are also becoming progressively more important to society over time.

Accordingly we have being pursuing acquisition strategies in cooperation with individual rural municipalities. The approaches used depend on the particular situation and the intent is to try and produce win/win outcomes. Also our primary concern is the long-term security of the land base, rather than who has management control. To date we have been quite successful:

- Large scale exchanges of tax recovery lands with multiple use values for public lands with agricultural values were completed with the Municipal District (MD) of Cypress in the 1983 to 1987 period. The department acquired some 66,000 acres of lands with habitat and conservation values.

- The MD of Acadia had a sale policy for its 84 quarter sections of tax recovery lands that comprised of native prairie. After hearing about the PCAP, an ESA Inventory was undertaken and the Public Lands Division worked closely and cooperatively with the council working out a trade deal that would see public lands under Farm Development Lease transferred in exchange for tax recovery parcels of mixed grass prairie rangeland. The trade was approved in principle by the council, the ratepayers, and the local Member Legislative Assembly and is now underway. The vast majority of the tax recovery lands that have environmental value will be secured. The old sale policy has been changed to a protection policy.

Inventory projects to map and identify the multiple resource values of the tax recover lands have been undertaken for both the MD of Taber and the County of Vulcan. Departmental officials have held preliminary meetings with both councils to outline where we would like to go from here.

This tool is particularly valuable because of the large amounts of land involved and the level of ongoing interjurisdictional cooperation that can be established. A prerequisite is an environmentally progressive council and much good will and open-mindedness on both sides. The process of developing arrangements is time consuming, complex, and iterative. There are many potential pitfalls along the way. The final results, however, speak for themselves.

GOOD MANAGEMENT

In the final analysis the most effective way of conserving native prairie environments is through good land management. There are some 3.2 million acres of provincial Crown land under grazing dispositions in the southern region and since range condition is a direct measure of ecological status, if each disposition can be managed in a manner that sustains the range in good condition then vastly more has been achieved in the name of ecosystem management and environmental protection than could ever be the case through the acquisition of lands for conservation purposes or the designation of protected areas. Currently, approximately 50% of Alberta's rangelands have been described as overgrazed (Wildlife Habitat Canada 1991).

Public Lands Division works hard to discharge its land management responsibilities in this area in a number of ways.

Grazing Reserve Program

This supervised grazing program provides affordable summer pasture for Alberta's farmers and ranchers on public land while also allowing multiple uses such as: 1) Recreation Use - hunting, hiking, trail riding, camping, and sightseeing; 2) Industrial Use - oil and gas well operators, pipeline companies, gravel haulers, and seismic crews; and 3) Environmental Quality - wildlife habitat, special ecological resources.

The reserves aim to operate on a cost recovery basis and ensure a sustained yield from the pasture. Patrons are charged a grazing fee calculated on an animal/unit/month basis and pay for salt, minerals, and pharmaceuticals.

There are eight provincial grazing reserves in southern Alberta encompassing some 400 mi^2, most of which is native prairie. Two large reserves in the environmentally significant Lost River/Milk River areas of southeastern Alberta alone encompass some 240 mi^2 of native mixed grass prairie which is maintained in good to excellent condition.

Field Services Program

The field services program is staffed by land resource agrologists each responsible for lease management and administration in defined areas. They work cooperatively with lessees on a disposition by disposition basis, conduct periodic inspections of grazing leases, provide range management advice to individual lessees, and develop lease management plans.

Field Services also maintains a series of 29 native prairie benchmark sites which are used to monitor current range management practices and ensure long-term sustainability of the grassland resource.

Range Management Program

The goal of the Range Management Program is the conservation, management, and sustained use of the rangeland resource. This program area undertakes range inventories, applied research, extension services, and special projects (last year it provided technical assistance to the Siksika Nation in developing a range management plan for the reserve grasslands). To date range inventories have been completed on 188,000 acres.

Each of these three program areas make valuable contributions to the conservation of native prairie environments. The drawbacks, predictably, are in resourcing at a time of dwindling budgets and competing societal values. The Provincial Grazing Reserve program budget has been trimmed on a number of occasions, Field Services are understaffed by about 50% and there is a single regional range manager for the entire region. Moreover, this is a time of jurisdictional uncertainty when various options for the reorganization of agency mandates are under consideration.

The main conclusions emerging from the above overview of land management techniques are:

1. That there is no shortage of available mechanisms.

2. That the various approaches can be used in concert to achieve complementary objectives—there is no one "best" approach.

3. That multi-partite approaches are very much more common than they used to be and are yielding impressive results.

4. That public land management approaches that achieve environmental protection objectives can make a big difference to the environment, to meet the needs and gain the support of landholders, and can be socially and politically acceptable.

5. That effective resourcing is becoming a more intractable problem over time and that nothing can be taken for granted.

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PLANNING WITH THE PUBLIC: THE MILK RIVER NATURAL AREA AND KENNEDY COULEE ECOLOGICAL RESERVE

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INTRODUCTION

Located within the Mixed Grassland Natural Region of southeastern Alberta, the Milk River Natural Area and Kennedy Coulee Ecological Reserve have been at the focus of various conservation and management concerns since the early 1970s. After two decades of study, evaluation, and controversy, a management plan has been completed which is intended to provide the framework for conserving a representative example of the Mixed Grassland Natural Region in Alberta. This article describes the pros and cons of the planning exercise from the earliest discussions regarding area conservation and committee formation through plan development to implementation.

As concern over the loss of native grassland within Canada increased, the Alberta Wilderness Association began to lobby for protection of a large area in southeastern Alberta known as the Milk River - Lost River Region in the early 1970s. This marked the beginning of a series of evaluations by both federal and provincial governments aimed towards preserving the area as one of the last remaining large blocks of relatively undisturbed native grassland.

In 1976, Canadian Parks Service identified the Milk River Canyon as a "Natural Area of Canadian Significance" along with Val Marie-Killdeer area in Saskatchewan and the Cypress Hills. The Val Marie area was eventually chosen as the site for Grasslands National Park and Cypress Hills received provincial parks status.

Around 1978, the area in question was withdrawn from the Lost River Ranch in accordance with the Public Lands Act which placed limits on the amount of land allowed under grazing disposition. The Alberta government subsequently considered the area as a candidate ecological reserve, one of the first in Alberta. A great deal of controversy revolved around the size of the proposed area and the restrictions that would be placed on such traditional activities as hunting and grazing. With the help of a non-governmental body known as the Milk River Task Force, an agreement was finally reached in 1987 resulting in the establishment of a small ecological reserve bordered by a larger natural area.

The Milk River Task Force also recommended the formation of a committee consisting of both government and non-government members. This led to the establishment of the Milk River Management Committee containing six government and five non-government representatives. Over the last year, the Milk River Management Committee has completed a management plan which is intended to provide the framework for conserving this representative example of the Mixed Grassland Natural Region in Alberta (Hood and Gould 1992).

THE PLANNING PROCESS

The planning exercise was characterized by multiple use philosophies and public consultation throughout the process. The local integrated resource plan deviates from other integrated resource plans because of the direct involvement of local stakeholders in the planning process.

The early stages of this planning process cannot be touted as a shining example of modern day textbook strategy. Regrettably, the opposite is true and the process may be more aptly described as "backwards planning by forward thinkers." To support this statement, I submit the following facts:

1. The proposal for ecological reserve status came long before there was legislation to allow such a designation.

2. Initial attempts to involve the general public only served to alienate the local community.

3. A use of the area was proposed and tendered out for bids before a draft management plan was written.

4. And finally, the draft management plan was written before the committee assigned to that task was established.

PROS AND CONS OF PLANNING WITH THE PUBLIC

Although the early stages of the Milk River planning process did not follow a predetermined format, it served to spark a great deal of interest within the general public which otherwise may not have occurred. Directly involving members of the public on a voluntary basis fostered a sense of ownership in the resource, something which is often ignored in planning projects. It is my experience that the negative aspects surrounding this approach are far outweighed by the positive aspects.

Direct public involvement often suggests unnecessary delays. The public may not be entirely familiar with the area itself, the historical background, or government procedures. The Milk River experience suggests that the amount of time required to brief public members is insignificant compared to the delays resulting from previous government involvement.

A large planning team can become unwieldy. In order for the system to work, each voice must be heard and a consensus reached on every issue. Obviously, adding participants to the planning team, be they government or non-government, can lengthen the process. Nevertheless, the formation of a planning team must include the major stakeholders and interest groups to ensure a broad cross section of ideas and fair representation on issues.

Complications can arise when non-government members participating actively in the planning process use political ties to gain leverage on an issue. Members of the public have the right to access the powers-to-be directly whereas government employees must follow rigid lines of communication. However, these same political connections can be extremely helpful to circumvent a cumbersome bureaucratic hierarchy.

One of the problems specific to the Milk River planning exercise was the attempt to combine two separate areas which are administered by two different departments under the one plan. Both the ecological reserve and the natural area have separate internal planning structures and combining the two produced a planners nightmare. However, with no pattern to follow, the Milk River Management Committee was not bound by rules and was free to plot their own course.

THE PLAN IN OUTLINE

On the surface, this plan resembles many other integrated plans as it contains biophysical information, current land uses, goals and objectives, management issues and strategies, and agency responsibilities. It is in the implementation section that the plan begins to deviate from normal procedures. The Management Committee developed innovative solutions that would provide flexibility while at the same time ensure long-term protection for the area.

The nongovernment members of the Management Committee formed a registered society. The society was issued a twenty-one year recreation lease with the society bylaws tying the members directly back to the management plan. This ensured that the Committee would have control over the management of the site and not be bound by government bureaucracy. This allowed the society to enter into a long-term grazing contract with a local rancher of their choice, dictate the conditions of the contract, and alter the strategy depending upon the results of the monitoring program. In addition, the funds received by the society from this contract are put back directly into the management of the site rather than general revenue.

The Management Committee established a long-term monitoring program which is strongly tied to the management plan. The results obtained from the monitoring program will be used to evaluate the effects of management activities on plant and animal communities and on rare species and their habitats. Funds to support this program are derived from a variety of government and private sources.

CONCLUSION

Ultimately, the success or failure of any planning exercise is not determined by the number of participants or whether they are government or non-government. Despite all the controversy, bureaucratic bungling, and endless delays, the Milk River experience demonstrated that planning with the public can be successful. This success can be attributed to one thing. All the members of the planning team agreed that the Milk River area was special and that preserving a representative example of the Mixed Grassland Natural Region for future generations was justifiable. It was this underlying premise, more than anything else, that produced the high level of commitment necessary to overcome biases, open the lines of communication, and achieve problem solving by consensus as opposed to compromise.

In retrospect, a great deal can be learned from the Milk River planning experience. As was the case with Milk River, conflicting resource management issues often make planning a necessary evil. Given the increasing public awareness of environmental issues and a demand for input, planning with the public may become a standard practise. The challenge facing the Government of Alberta and specifically the Milk River Management Committee is, "Can we manage this area as well as our ranching predecessors?" In my own mind, the jury is still out and the verdict will not be heard for several years.

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TALL-GRASS PRAIRIE CONSERVATION IN MANITOBA

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Manitoba is the only prairie province in which tall-grass prairie is found although tall-grass prairie remnants also occur in southwestern Ontario. Prior to the start of the following projects, only two sites comprising less than 50 ha were protected and managed as tall-grass prairie in Manitoba.

TALL-GRASS PRAIRIE INVENTORY

In 1987, the Manitoba Naturalists Society (MNS) initiated the Tall-Grass Prairie Inventory which was the first systematic inventory of tall-grass prairie in the province. Funding from the MNS and the World Wildlife Fund's (WWF) Wild West Program allowed for the hiring of two field technicians while the Manitoba Department of Natural Resources (DNR) provided office space and logistical support. Field staff located potential sites by using black-and-white aerial photographs, land use maps, and referrals from outside sources. Sites were subsequently ground-checked and then ranked using native species dominance, abundance and diversity of native species, and evidence of disturbance as criteria. Although field staff surveyed only 19% of the primary study area that year, it was enough to document the rapid and continuing decline of the tall-grass prairie in Manitoba and to spur the interest and concern of government and other organizations.

TALL-GRASS PRAIRIE CONSERVATION PROJECT

Increased support from initial participants, and the inclusion of Wildlife Habitat Canada (WHC) as a funding partner, allowed for the expansion of efforts in 1988 and the project was renamed the Tall-Grass Prairie Conservation Project (TGPCP) (Joyce and Morgan 1989). Summer field staff increased to three technicians, and for one year, a cartographic technician and a project coordinator were hired. Inventory work continued while the project goals were expanded in an effort to generate an awareness of the importance of tall-grass prairie that would lead to its preservation. To this end, the project produced a brochure and a 20-minute film on Manitoba's Tall-Grass Prairie (the film is available in 16 mm or VHS video format from the MNS). The brochure has been widely distributed to landowners and the general public. In addition, the project solicited funding for, and acquired, two prairies. One of these, a 32 ha site, is now part of the Oak Hammock Marsh Wildlife Management Area and the other is a small 2.4 ha prairie in the Rural Municipality of Hanover.

By the end of 1988 the project had surveyed over 3000 potential sites in both the primary and peripheral areas. Of those, only 88 sites totalling 2000 ha were considered to contain good quality (C ranked or better) tall-grass prairie. The primary study area generally coincided with the basin of ancient Glacial Lake Agassiz and contained rich black soils which have been extensively used for agriculture. Only 22 sites with a mean size of five ha were found in this area. The largest site was 20 ha and only three other sites were 10 ha or more in size. One-half of these prairies were found on railway rights-of-way. The peripheral area, surrounding the primary study area, is characterized by poorer, stonier soils and has been primarily utilized as native hay and pasture. A total of 66 sites with a mean size of 29 ha were found in this area. The largest site was 120 ha and 20 other sites were 40 ha or more in size. Two-thirds of the sites in the peripheral area were on pasture or haylands. It is apparent that the majority of tall-grass prairie remaining in the province today is in the sparsely wooded areas of grasslands peripheral to the true tall-grass prairie zone. One of the main recommendations in the final report from the TGPCP was the establishment of a 1000 ha preserve in this area (Joyce 1989).

CRITICAL WILDLIFE HABITAT PROGRAM

In 1989, the TGPCP became part of a new initiative called the Critical Wildlife Habitat Program (CWHP). This program is the result of a five-year agreement between WHC, the DNR, Manitoba Habitat Heritage Corporation, WWF, and the MNS. All parties contribute financially to the program and are represented on a Steering Committee which guides the direction of the program. The DNR administers the various program components which include management, extension, stewardship, and acquisition. Tall-grass prairie is only one of the areas covered by this program which deals with critical wildlife habitat in all of agro-Manitoba. The program has produced a management manual for prairie grasslands and also initiated an inventory of mixed grass prairie as well as continuing the tall-grass prairie inventory. Under the program, $35,000 per year has been allotted to the acquisition of tall-grass prairie and in the first three years of the program 350 ha were purchased.

PRAIRIE PATRONS PROGRAM

In late 1989, the MNS initiated a new fund raising venture, called the Prairie Patrons Program (PPP), to raise additional funds for tall-grass prairie acquisition. Under this program, Prairie Patrons donate $50 towards the purchase of one acre of prairie. Patrons receive a tax receipt and an honourary certificate issued in their name. Once a prairie site has been purchased, patrons are invited to the official opening of the prairie and are also notified of field trips to the area. To date, over $40,000 in donations have been received through the program. Additional funding from the Nature Conservancy of Canada and two matching grants from the Province of Manitoba's Special Conservation Fund have allowed for the acquisition of three prairies totalling 260 ha.

TALL-GRASS PRAIRIE PRESERVE

The tall-grass prairie preserve is in southeastern Manitoba between the towns of Tolstoi and Gardenton. Although this area occurs in the sparsely wooded grasslands adjacent to the historic tall-grass prairie zone, it nevertheless contains some of the best tall-grass prairie remaining in the province. The size of the preserve was increased to allow for the inclusion of a second area which is approximately 10 km north of the original proposed preserve. This second area was included because it is the only known location in Canada for the Western Prairie Fringed Orchid (*Platanthera praeclara*) and because it contains some excellent examples of oak savannah. Other rare orchids found within the preserve area include the endangered Small White Lady's-slipper (*Cypripedium candidum*) and the Great Plains Ladies-tresses (*Spiranthes magnicamporum*). Purchase of land for the preserve has been ongoing through the CWHP and the PPP which have collectively acquired a total of 610 ha. It is anticipated that all available land in the preserve area will be purchased by 1994. Although some of the land will remain in private hands, the CWHP hopes to use land owner agreements to help preserve the integrity of the preserve.

The area around Tolstoi and Gardenton contains many fine examples of the cultural heritage of the predominantly Ukrainian settlers that homesteaded there. St. Michael's Church, the oldest permanent Ukrainian Church in Canada is adjacent to the preserve and a Ukrainian Museum is located in the town of Gardenton. These and other historical features provide an excellent opportunity to establish a preserve that could highlight both the natural and cultural history of the area. The CWHP is currently in the process of establishing a local advisory committee, to ensure that local concerns are represented, as well as drafting a management plan for the preserve area and a long-term management agreement. Hopefully, cooperative efforts can ensure that the proposed preserve becomes a reality, not just for the short-term but for many years and many generations to come.

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HOLISTIC STEWARDSHIP OF PRAIRIE FRAGMENTS

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INTRODUCTION

Given the fragmented state of the prairies, a primary concern is how small protected areas can be managed most effectively to achieve a representative and ecologically viable network of prairie ecosystems. Current thinking in protected areas stewardship advocates the need for a holistic approach which better integrates protected areas into local communities and landscapes. This paper describes holistic management, provides a rationale for its use, and summarizes steps to achieving it. A small protected area is broadly defined here as a site, less than 1000 hectares, officially reserved for the conservation of nature. This definition encompasses everything from national parks to private lands and excludes campgrounds, picnic areas, parkways, and historic sites with no nature conservation objectives.

Value of Small Protected Areas

While it is generally recognized that bigger is better when it comes to protected area size (McNeely and Thorsell 1991, Schonewald-Cox 1983, di Castri and Robertson 1982, Sargent and Brande 1976, Diamond 1975) the current state of the prairies leaves little choice—all that remains are fragments of a once vast ecosystem. However, regardless of size, fragments can make important contributions towards achieving the goals of the Prairie Conservation Action Plan. The value of small protected areas, grouped here into three functions, are worth re-affirming to guide management actions.

Function 1. Reduction of Habitat Isolation Caused by Fragmentation

Habitat fragmentation has been identified as a leading cause of species loss and ecosystem function disruption, resulting in deterioration of ecological viability (Saunders et al. 1991, Reid and Miller 1989, Wilcove et al. 1986, Harris 1984, Mader 1984, Whitecomb et al. 1981). Small protected areas, although fragmented themselves, have the potential to reduce the negative impacts of fragmentation of larger tracks of wildland. Through effective reserve design and management, these ecosystem remnants can function as transition (buffer) zones, conservation corridors, and/or migratory stopover points (Reid and Miller 1989, Webb 1987, Noss 1987, Soulé and Simberloff 1986, Harris 1984). Thus, small protected areas can function as living stepping stones that bridge the gap between large isolated natural areas.

Function 2. Conservation of Biodiversity

Although it is preferable to protect large tracts of wildlands, the preservation of biodiversity does not always require extensive areas. For example, a wild perennial species of maize (all other forms of maize are annuals) which could save farmers several hundred million dollars a year, was discovered growing on a mere four hectares of land (Fisher 1982). Simberloff and Gotelli (1984) and Saunders et al. (1991) indicate that small protected areas can be used to maximize the variety of habitat types conserved, provide multiple evolutionary opportunities, preserve taxa of highly restricted ranges, and protect breeding/nesting areas. Together these functions contribute to the conservation of biodiversity on both local and regional scales.

Function 3. Enhancement of Pro-conservation Attitudes

Establishing and maintaining a network of ecologically viable protected areas is largely dependent on a strong constituency of supporters. Small protected areas provide opportunities for nature related recreation, research, education, and employment. Through these opportunities, small protected areas can become catalyst sites for fostering positive attitudes toward conservation efforts (Cole 1983, Sheail 1976). This is an especially important role for urban protected areas since urban populations wield significant political and economic power yet tend to be largely alienated from the natural world (Lusigi 1988).

CURRENT THINKING IN PROTECTED AREA STEWARDSHIP

Based on the current thinking in protected areas stewardship, if the above conservation values of small protected areas are to be maximized, a holistic systems approach to protected areas management is essential (Machlis and Tichnell 1985, Ugalde 1989, Lusigi 1988, Agee and Johnson 1988, McNeely 1989, Canadian Environmental Advisory Council [CEAC] 1991). A holistic or ecosystem management approach is similar to the "zone of cooperation" approach embodied by the biosphere reserve concept which recognizes the need to integrate conservation lands into the regional socioeconomic and ecological situation (di Castri and Robertson 1982). It is externally oriented and addresses political, economic, and cultural factors in addition to biological ones both within and outside the protected area boundaries. The underlying philosophy of holistic stewardship is that the long-term survival of protected areas is dependent upon the understanding and support of communities living within or near protected areas. This support can be gained through partnerships with landowners, research institutes, and other resource management agencies; through active public participation in establishment and management of protected areas; and through mechanisms which allow local communities to benefit both socially and economically from the existence of protected areas (Einsiedel in press, Ugalde 1989). The rationale for holistic stewardship of protected areas is evident from studies in landscape ecology, human ecology, and empirical data on commonly reported threats to ecological viability.

RATIONALE FOR HOLISTIC STEWARDSHIP

Insights from Landscape and Human Ecology

Research in landscape ecology (Zonneveld and Forman 1990, Noss 1987) and human ecology (Machlis and Tichnell 1985) indicate that protected areas are systems functioning within a larger regional system of landscape patterns, processes, and land uses. The defining characteristic of landscape ecology is that the landscape can only be understood by viewing it as a whole. Thus, the land is seen as a complex interaction of open, dynamic entities rather than a collection of isolated, static objects. Understanding the spatial and temporal interconnections within the landscape mosaic is fundamental to this holistic perspective.

Applying this holistic systems approach to the protected area, one then sees that the protected area is not a self-contained unit. Rather it is an incomplete system, "embedded in a wider regional ecosystem and is influenced by the population, organization, technology and environment that surround and interact with it" (Machlis and Tichnell 1985:32). When protected areas are managed in isolation from the regional ecosystem context, there can be negative social, economic, and ecological reactions. For example, protected areas managed as islands separate from society may be viewed as "locked-up resources." Another common perception is that parks are "distant, pretty places for tourists, scientists, and biologists" and that "conservation (is) a movement to halt development" (Ugalde 1989). Holistic management can help to change these harmful perceptions by integrating protected areas with the "needs and aspirations of society" (CEAC 1991). In addition to socio-economic implications of isolation, there are ecological impacts. Studies in landscape ecology suggest that integrity and continuity of ecological processes are dependent upon the size, shape, and connectedness of habitats within the landscape matrix. Fragmentation of contiguous landscapes results in both loss of habitat and isolation of habitats with severe consequences on ecological viability of the remaining fragments (for a comprehensive review of fragmentation see Saunders et al. 1991). A holistic management approach is needed to re-connect habitat patches and to re-connect people with natural places.

The need to manage protected areas holistically is furthered emphasized by taking a closer look at the protected area as a human ecosystem. A useful conceptual model developed by Wright and Machlis (1984) identifies the subsystems within a protected area (air, water, soil, vegetation, fauna, cultural resources, visitors, and support infrastructure), the processes connecting these internal subsystems, and the linkages between the protected area and the larger regional ecosystem. The model demonstrates that protected areas are complex systems which require complex, holistic management approaches. Dealing with a single species or subsystem in isolation from the others is likely to cause problems. The complexity also demands a team approach to management. No longer can one person effectively manage protected areas by being a technical specialist in one or even several disciplines. The complexity of protected area ecosystems and their dependency on the regional ecosystem in which they function, requires a diversely knowledgeable person who has the ability to lead a team of players from all sectors of society. From this model it also is apparent that humans are a significant part of the protected area ecosystem, therefore social and cultural factors such as population demographics; economic and political policies; and the needs and aspirations of local communities, need to be incorporated into establishment and management plans. Lastly, and perhaps most importantly, this conceptual framework shows that protected areas are open, dynamic systems. The political boundaries are, of course, artificial and rarely correspond to ecological boundaries. What happens outside the boundary, whether it be pollution, industrial development, or protection of critical habitats by local landowners, will certainly influence the protected area's health and long-term sustainability. External influences are of particular importance to the ecological viability of small protected areas. For example, Saunders et al. (1991) indicated that small ecosystems tend to be externally driven and Odum (1986) stated that the smaller the ecosystem the more sensitive it is to external forces. And in the words of Reed Noss (1987:5), "smaller reserves with larger perimeter-area ratios have proportionately greater management problems resulting from interactions with the surrounding landscape and its human and non-human inhabitants." Thus, the need to have a landscape perspective, to be cognizant of the ecological and socioeconomic systems in which the small protected areas functions, and to work cooperatively with local communities and governments is magnified for stewards of small protected areas.

Threats to Long-term Ecological Viability

Further evidence supporting the need for integrative management was shown in a recent University of Alberta study. To set training objectives and develop a curriculum for the Protected Areas Management Certificate Program, we conducted a survey of managers in the United States and Canada to obtain answers to the following three questions: What are manager's perceptions of current training needs? What are the common threats to long-term ecological viability? What are the common areas of management inadequacy in existing programs? The response from over 450 managers representing all categories of protected areas suggest that a holistic management approach which breaks down the artificial barriers between protected areas and surrounding cultural and natural communities is necessary to achieve excellence in management (for details see Brown et al. 1992, Einsiedel and Brown 1992). Specifically, the most common threats to long-term ecological viability for small protected areas were: 1) lack of funding and staff, 2) human encroachment, 3) industrial and agriculture activities, 4) human abuse and misuse of the protected area, and 5) exotic species invasion. These results suggest that the most serious block to developing an ecologically viable system of protected areas is the widespread lack of society's appreciation, understanding, and support of these sites and natural areas in general. This is evident from the external nature of threats to ecological viability. Of significance is the widespread under-allocation of financial and human resources given to protected area agencies which in turn has many negative ripple effects in terms of their ability to properly protect, inventory, monitor, and promote protected areas. Overall, the threats to long-term ecological viability provide empirical evidence for the importance of focusing management efforts beyond the reserve boundaries.

HOLISTIC MANAGEMENT - TURNING OBSTACLES INTO OPPORTUNITIES

The complexity of protected areas and severe threats to their long-term survival may seem overwhelming. However, through cooperation, networking, and innovation, these obstacles can become exciting opportunities to involve people in protected areas stewardship and thereby develop a widespread land ethic. For instance, to overcome the shortages in financial and human resources, new programs to encourage the participation of local people and organizations are emerging. The following is a guideline to developing a holistic management program adapted from an International Union for the Conservation of Nature (IUCN) management effectiveness checklist (IUCN 1986):

1. Systems plan (including land acquisition, corridor and land-use zoning).

2. Cultural and ecological information base.

3. Measurable management objectives.

4. Written, implemented, and monitored management plan.

5. Pro-active research program with research opportunities for universities, colleges, etc.

6. Public relations and communications program.

7. Mechanisms to actively involve local communities in site planning and management such as volunteer programs, local advisory committees, and public environmental reviews.

8. Program to establish and demonstrate real benefits to local people such as employment opportunities, eco-tourism, erosion control, etc.

9. Visitor services and interpretation program.

10. Conservation education program including school programs and community out-reach activities.

11. Innovative fund raising program.

12. Active management program to restore dysfunctional ecological processes and mitigate external threats.

13. Landowner contact program.

14. Ongoing staff training.

CONCLUSION

Through a holistic, landscape perspective it becomes obvious that protected areas are strongly interconnected and dependent on the social, economic, and ecological systems in which they function. It is also evident that protected areas alone will not be sufficient to achieve conservation goals. Nowhere is this more evident than the prairies where the greater portion of remaining prairie habitats is under private ownership. Here the need to work cooperatively with landowners and all the players in the prairie landscape mosaic is imperative. A holistic stewardship approach sets the atmosphere for achieving these urgent goals.

No specific action steps or recommendations were generated during the workshop on the stewardship of small protected areas. However, it was evident from the discussions that there is a strong need for practitioners to share common management challenges, solutions, and ideas, especially pertaining to specific management techniques. The University of Alberta's Protected Areas Management Program is looking at the possibility of assisting in organizing a network among stewards which could meet this need. Anyone interested in such a network and has skills, ideas, or funding to offer is encouraged to contact Lesley Brown at the above address.

ACKNOWLEDGMENTS

The research conducted at the University of Alberta was financially supported by the Recreation, Parks and Wildlife Foundation; Alberta Forestry Lands and Wildlife; and the Protected Areas Management Program, Faculty of Extension, University of Alberta. Ongoing research in effective management of small protected areas is being supported by Wildlife Habitat Canada.

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CASE STUDY: LIVING PRAIRIE MUSEUM

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The Living Prairie Museum is a forty acre preserve consisting of 32 acres of endangered tall grass prairie. It is one of the City of Winnipeg's urban natural area parks. Urban natural areas have three purposes: 1) site preservation; 2) education of the public; and 3) recreation compatible with its preservation.

HISTORY

This tall grass prairie site was originally identified through the International Biological Programme Survey of 1968 (J. Shay, pers. comm.). After three years of lobbying between various citizens groups and the former City of St. James, one sixth of the original 150 acres was preserved in April of 1971. In 1974, the prairie park became part of the newly unified City of Winnipeg. In 1975, the present Interpretive Centre was built, in 1976, staff were hired and the first interpretative programs began. In 1981, an additional eight acres was added to the preserve.

INTERPRETIVE PROGRAM

The current interpretation program involves education and general public components.

Interpretation for the general public begins operation in April with the blooming of the Prairie Crocus (*Anemone patens*), Manitoba's floral emblem. From this annual event the centre is open weekends until the end of June, daily during July and August and again on weekends in September. Displays, slide programs, a self-guiding trail system, guided walks with naturalists, and workshops components comprise the program for tourists and the general public.

The environmental education program offers half-day programs based on the Manitoba Science Curriculum involving topic-specific orientation and interpretive walks with naturalists spring through fall. During the winter season an off-site program is offered to schools and special groups on a variety of environmental subjects.

INITIAL MANAGEMENT

The Living Prairie Museum exists as an island in an urban sea of housing, streets, industrial buildings, and schools. Initial management priorities included periodic burning, control of Canada Thistle (*Cirsium arvense*), and restoring a damaged site on the preserve.

The Living Prairie had several disturbed areas which have allowed for the establishment of alien species such as Brome Grass (*Bromus inermis*) and Canada Thistle. The largest area, of two to three acres, was damaged in the seventies during construction of adjacent apartment buildings. An early solution was to set up a restoration project. The seed source for the plant species was Wisconsin because local seed sources were nonexistent. Now it is considered unacceptable to grow seeds more than three hundred miles from their place of origin. Quite strangely because of this restoration plot the Living Prairie Museum has Compass Plants (*Silphium lacinatum*) and Rosinweed (*S. integrifolium*) which originated from the upper mid-western United States. They are not a threat to the integrity of the preserve. They have not adapted well to the short growing season and drier conditions in southern Manitoba.

Prior to 1986, the controlled burns tended to be conducted opportunistically by Parks and Recreation maintenance personnel. The burns were not specifically timed for any particular management objectives. As a result over time the percentage of shrub cover had increased, and certain native prairie species were felt to be receding in abundance.

CURRENT MANAGEMENT

In the mid '80s a new approach at managing the preserve was taken. A steering committee of professionals was put together for advice on management of this preserve. A literature search was conducted to gather information relevant to management of this unique tall grass prairie. The following objectives were defined: 1) control invading successional woody plant species; 2) decrease exotic or alien plant species; 3) enhance native prairie species; 4) organize or re-establish a monitoring system to analyze plant species change over time; and 5) determine the best management tools to meet the above objectives.

The invading shrubs were determined to be Wolf Willow (*Elaeagnus commutata*), Trembling Aspen (*Populus tremuloides*), Western Snowberry (*Symphoricarpus occidentalis*), and to a lesser extent Caragana (*Caragana arborescens*) which was spreading from an old remnant farmyard.

Invading alien herbaceous plant species included Canada Thistle, White Sweet Clover (*Melilotus alba*), Alfalfa (*Medicago sativa*), and Brome Grass.

Based on the current information available for the targeted species a managed late spring burn program was considered to be optimum in controlling all of the unwanted target plants. Managed burns would also be conducted on a more scientific basis. Wind speed, temperature, humidity, barometric pressure, and fuel loading were among the factors taken into account before conducting a controlled burn.

The 1981 burn study, which had been discontinued, was reinstated in 1986. Data was collected annually on the changing conditions of the species diversity and composition of the tall grass prairie preserve.

The 1977 Restoration Plot with its imported plant species was adopted as a tool for education and interpretation purposes. A separate trail loop was mown to the site. Interpretation of the plot was included on tours and in self-guiding trail brochures.

Additional alien species were removed by hand-pulling through the use of "fine option" volunteers (who were working off traffic fines) and by the naturalist staff. Species which were hand-pulled included Sweet Clover, Canada Thistle, Wild Asparagus (*Asparagus officinalis*), and Alfalfa. Hand-pulling of Sweet Clover and Canada Thistle was the most successful and a substantial reduction has occurred on the preserve since pulling was initiated.

In 1989, management of the woody successional species was assisted by labour intensive hand application of herbicide to a single Wolf Willow clone which expanded out of control. Chemical control was the only reasonable method of returning that particular area of the preserve back into tall grass prairie because the size of the clone had become so large. This clone was not eliminated but rather contained.

WHAT ARE THE END RESULTS?

The first five years of this revised management approach appeared to result in the following: a decrease in non-native cool season grasses such as *Poa* species; enhancement of warm season grasses; a decrease in aliens such as Sweet Clover and Canada Thistle; and decrease in monotypic Wolf Willow and Aspen clones on the preserves

FUTURE MANAGEMENT OBJECTIVES

Three primary objectives have been set up: to analyze the burn study data to yield more concrete figures on species composition, species diversity, percentage cover of grass, forbs, and woody species, and change or shift in species composition if any. On other tall grass prairie preserves it has been found that small preserves are frequently subject to composition change because the management techniques cannot or will not duplicate the historical controls of fire and grazing by Plains Bison (*Bison bison*). The primary alien plant invader is now Brome Grass. Options for its control will be analyzed. Girdling of Trembling Aspen has been added to control suckering in some areas and continued hand-pulling by volunteers of Sweet Clover, Canada Thistle, and Wild Asparagus will be carried out.

CONCLUSION

The Living Prairie Museum is a unique mesic prairie remnant which was classified as an "A" quality prairie by the Tall Grass Prairie Project. It has specific site problems which have to be addressed individually. In addition, in a time of decreasing budgets, creative ways of getting the job done are necessary.

HELPING ENDANGERED SPECIES: COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA AND RECOVERY OF NATIONALLY ENDANGERED WILDLIFE. IS THIS THE BEST THAT WE CAN DO?

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INTRODUCTION

After a 13 year effort, 213 Canadian species have been placed on the COSEWIC (Committee on the Status of Endangered Wildlife in Canada) list. Although 20 to 30 reports may be reviewed each year, the rate at which species are added to the list in Canada does not reflect the rate at which they become endangered. On the other hand, the RENEW (Recovery of Nationally Endangered Wildlife) program was established in 1988 to develop a national strategy for the recovery of endangered species. So far, 23 recovery teams have been assembled for the 37 eligible species and only three recovery plans have been approved, two in 1986 prior to RENEW and the third has yet to be printed. This should be measured against a background estimate of 8,643 Canadian terrestrial, freshwater, and marine species of plants, animals, and microorganisms that are endangered or already lost (Mosquin and McAllister 1991). The purpose of this paper is to present a critical evaluation of these programs and suggest new ways to tackle the challenge of biodiversity conservation in Canada.

COSEWIC, 13 YEARS OF LISTING ENDANGERED SPECIES

COSEWIC is responsible for preparing an official national endangered species list, which is viewed with a great deal of respect and credibility. It is important that this credibility be maintained and that both the public and governments understand (and consequently support) listing of species by COSEWIC. As long as this is the case, species on the COSEWIC list enjoy special consideration, even though they may have absolutely no legal protection.

It is important that COSEWIC not fulfil a mere cataloguing function, as appears to be the case when the committee listed as extirpated the Illinois Tick-trefoil (*Desmodium illinoensis*), a plant which is known from Canada from a single specimen collected more than 100 years ago. Rather, COSEWIC's activities should advance action on endangered species. Consequently, priority of status designation should be given to those species for which something can and should be done before their situation deteriorates further. We could, for example, concentrate our efforts on keystone and critical-link species, those often anonymous species that are considered to play a vital role in ecosystem function (Westman 1985 *in* Westman 1990) such as invertebrate and plant species. Concerns about priority of listing have been expressed by some COSEWIC sub-committee chairmen, particularly by Dr. Erich Haber who is looking at some 500 plant species that are candidates for review. Such situations indicate that it is perhaps time to start using a habitat approach, i.e., designate habitats (rather than, or in addition to, species) so that, if protected or rehabilitated, the future of all species in those habitats is safeguarded. In this respect, the ecosystem approach to wildlife conservation suggested by the Ontario Wildlife Working Group (1991) must be commended.

Identification and preservation of critical habitats (old-growth forests, marshes as well as wintering, nesting, or calving grounds) or biodiversity hotspots is another approach that should be considered at the national level. Alfonso (1991) describes how Geographic Information Systems (GIS) can be used to select areas rich in species or endemics for protection. Anderson (1984a, 1984b) demonstrated that hotspots for major groups of organisms do not differ substantially. The recent establishment of Conservation Data Centres by the Nature Conservancy and the GIS data base of rare Canadian plants currently being compiled by Dr. Haber should definitely contribute to identifying these critical sites.

The approach of the Québec Endangered Species Act to that problem is worth mentioning. The act provides for the establishment of a list of species susceptible of being designated as vulnerable or threatened and for which protective measures may be taken to ensure their survival (even prior to their inclusion on the official list).

As COSEWIC does its work it continues to run into "new" situations, which must be dealt with in a logical, consistent manner. Currently, there are problems with listing populations, with listing species that reach the northern limit of their distribution in southern Canada, and with the creeping in of political considerations.

Listing of Populations

The Plains Grizzly Bear (*Ursus arctos*) is a case in point. In April 1991, it was listed as extirpated. One must question the point of listing this animal at all, as no one is really sure whether there ever was a Plains Grizzly from the taxonomic point of view. Thus, we must assume we are dealing with part of the geographical range of the species. In that case, listing the Plains Grizzly goes against COSEWIC's own definition of an extirpated species: any indigenous species of fauna or flora no longer known to exist in the wild in Canada but occurring elsewhere.

There are other considerations. Does it make sense to list a species as extirpated from part of its range? On the surface, this seems reasonable, even desirable, but problems arise if this is followed to its logical conclusion. Almost every Canadian species no longer occupies its entire original range. Should we then list species such as the Timber Wolf (*Canis lupus*) which no longer occurs over much of southern Canada? What about the Wolverine (*Gulo gulo*), American Marten (*Martes americana*), Fisher (*M. pennanti*), etc.? If we take this even further, we could end up in absurdities, such as listing very common species, for example, deer absent from cities. Also, almost every species now on the COSEWIC list would have to be revisited and listed as extirpated over parts of its range. In addition, how will COSEWIC deal with any of the currently listed populations if they should disappear?

Division of species into geographic populations (not necessarily coincident with taxonomic differences) certainly serves to draw attention to the plight of species in trouble in certain areas and encourages maintenance of populations over their entire recent ranges, which is very important. Moreover, it is very valuable for management purposes. At the same time, it gives rise to the problems discussed above. In addition, it confuses the public. Further it can be responsible for the addition of a large number of entries to the endangered species list, giving the impression that COSEWIC is being alarmist.

There does not seem to be an easy solution to this dilemma. It may be advisable to avoid, as much as possible, listing populations as separate entries and restrict listing to taxonomic groups only, down to the subspecific level. In that case, it would be necessary to find other means of drawing attention to the plight of populations. Perhaps a separate list would be useful. The danger is that this second list might not be taken as seriously as the "main" list, or be largely ignored.

Northern Distribution Limits

There are a number of species with most of their distribution range occurring in the United States and barely reaching into southern Canada. Many of these get listed as vulnerable, as their populations in Canada are so small that they can easily disappear. Some get listed in more serious categories. Yet, some of these species occur over a wide range in the United States, and some are common there. Moreover, population fluctuations at range limits are a normal occurrence. By placing such species on the list, COSEWIC gives them the same importance as it does to species that are truly in trouble over most or all of their range.

For example, in April 1991, the Illinois Tick-trefoil was added to the list as extirpated. Yet, it is known to have occurred in Canada from only one collection made in 1888 in southern Ontario, and has never been seen since. In this case, the species has a fairly large distribution in the United States, but has never been abundant there. Nevertheless, it does not deserve the same importance as the Black-footed Ferret (*Mustela nigripes*) or Swift Fox (*Vulpes velox*). The case of the Illinois Tick-trefoil is probably the most extreme in that it is probably a case of sporadic range extension. However, a number of other species are listed because their ranges extend only into small portions of Canada. It might be more practical, and certainly more sensible, to look at the health of species on an ecosystem basis, rather than taking political boundaries into consideration.

COSEWIC is in a bit of a bind on this one, however, as its mandate is to deal with the status of species in Canada, irrespective of their status in the United States. However, there is no doubt that other species are much more deserving of attention. There is also a danger that COSEWIC may be taken less seriously if it lists species at the northern limit of their ranges in the same categories as species that are truly in trouble in Canada. Nevertheless it is the responsibility of each nation to preserve its biota, whatever their condition elsewhere. In some cases, it is the United States population which is of greater concern. We could, 1) rate species differently or 2) fund preferentially those species in the greatest overall danger.

Political Considerations

A feature of COSEWIC is that range jurisdictions for any given species have a special say. This can be both positive and negative. Range jurisdictions often have a better understanding of what is happening and why, so their judgement on a matter can be very valuable. However, politics tend to creep in.

For example, the Polar Bear (*Ursus maritimus*) had been up for consideration for several consecutive years. Every time, COSEWIC believed that it should be listed but the range jurisdiction successfully argued for deferral. In 1991, even the range jurisdiction agreed that from the purely biological point of view, the Polar Bear should be listed, but still argued against listing for political reasons.

Another example of political intervention was the Sharp-tailed Sparrow (*Ammodramus caudacutus*) which was deferred only because the range jurisdiction, Québec in this case, asked that it not be considered because no Québec representative would attend the COSEWIC meeting as a result of the failure of the Meech Lake constitutional accord.

If COSEWIC is to do a proper job, hard scientific facts must be the sole basis upon which status is allocated. Theoretically, and to a large extent practically, this is the case now. However, it is not always the case. Consequently, a way must be found to eliminate political intervention. In this respect, we should pay attention to the suggestions made by Mace and Lande (1991) concerning the status attribution process.

RENEW—ACTING TO PRESERVE BIODIVERSITY

Being on the COSEWIC list does not offer a species any formal protection or confer any legal status. A few provinces have endangered species acts, but there is no consistency, and most provinces still do not have any endangered species legislation at all. However, because COSEWIC is respected and has credibility, species on the list often receive special consideration from governments, conservation organizations, and even from industry. As a result, environmental impact assessments take endangered species into consideration and recommend mitigation measures to maintain populations. Most efforts, however, are not as well organized and coordinated, and thus are not always as effective as they could be.

In 1988, the establishment of RENEW was seen as a good way to have all agencies, organizations, and individuals work together to help species at risk.

Unfortunately, RENEW does not deal with plants, invertebrates, fish, or marine mammals. It deals only with terrestrial vertebrates (birds, mammals, amphibians, and reptiles) that have been listed by COSEWIC as threatened, endangered, or extirpated. This means that even within these taxonomic groups, RENEW does not deal with species in the vulnerable category. So, whereas COSEWIC is restrictive, RENEW is even more so; it is committed to addressing only 37 of the 213 listed species (17%). Canada's marine fauna is given low priority even though we have the longest coastline of any nation, and possess 6.5 million km^2 within our 200 mile fishing zone and our Arctic Sector (versus 10 million km^2 of terrestrial habitat).

Although the creation of RENEW is a positive step, progress has been very slow. In 1989, RENEW made the commitment to have, by 1991, recovery teams in place for all 26 species eligible at that time. Recovery plans for 12 species were to be approved by the fall of 1990, for 12 more species by a year later, and the remaining species by the fall of 1992. However, we are still struggling with the creation of recovery teams and preparation and approval of recovery plans. By February 1992, the number of eligible species had increased to 37. Recovery teams have been assembled for 23 of these. To that date, only three plans had been approved: Whooping Crane (*Grus americana*), Peregrine Falcon (*Falco peregrinus anatum*), and Piping Plover (*Charadrius melodus*). Another seven plans have been submitted but are not yet approved, and 12 other draft plans are in preparation. Obviously, the process is painfully slow. A great deal of time and money is required for this species-by-species approach. The implementation of the habitat approach would be much more effective, especially for species groupings requiring similar conditions. Such areas for plants could be easily located using Dr. Haber's GIS system.

One way to speed up this process is through greater inter-agency cooperation and development of new partnerships. For example, RENEW should establish closer working relationships with Forestry Canada, Fisheries and Oceans Canada, the Canadian Council on Ecological Areas and the Canadian Museum of Nature (the latter has one of the nation's largest biodiversity data bases, BIODIV). The establishment of conservation networks has recently been suggested in order to protect and manage the large natural areas needed to sustain key species as well as the integrity of entire ecosystems (Salwasser et al. 1987). Recovery teams should identify and integrate in their recovery plans nongovernment organizations (NGOs) and institutions such as zoos, aquariums, botanical gardens, conservation organizations, science museums, interpretation centres, colleges, and universities, that could help them fulfil their mandate at the local level. Government authorities that oversee conservation efforts should formally recognize the financial, scientific, and/or technical contributions of private corporations, NGOs, and private or public institutions to recovery plans by signing memoranda of agreement. These memoranda of agreement would not only help to ensure long-lasting cooperation between organizations (Salwasser et al. 1987) but could foster the contribution of other, previously unknown partners to the immense task of preserving biodiversity (Prescott and Hutchins 1991).

Provincial and territorial jurisdictions are key players in the protection of biodiversity. Through the recent endorsement of "A Wildlife Policy for Canada" they have recognized the maintenance and reestablishment of biodiversity as one of their major goals. They must now increase their contribution to RENEW and ensure that sufficient funding is available. In addition, ways must be found to deal with the 83% of COSEWIC species not currently eligible under the RENEW program, and those yet to be listed by COSEWIC.

OTHER INITIATIVES

Although COSEWIC and RENEW are important when dealing with endangered species, they are, by no means, the sole players. Over the years, much has been done without these two committees. Whooping Cranes would probably be extinct by now if it hadn't been for the work done by interested people and governments before either COSEWIC or RENEW ever existed. Vancouver Island Marmots (*Marmota vancouverensis*) have also received help prior to the existence of RENEW. Captive breeding and subsequent reintroduction efforts have been initiated by dedicated people and government for the Swift Fox and Peregrine Falcon. But perhaps the biggest success story is that of the American White Pelican *(Pelecanus erythrorhynchos*). This species was listed in 1978 by COSEWIC as threatened. Even though no RENEW recovery plan was ever written for the species, Canada Life (whose corporate logo is the American White Pelican) and World Wildlife Fund (WWF) Canada combined forces and did some tremendous work. As a result, the pelican was removed from the list in 1987, the only species to have ever been delisted.

One might ask: Is any attention being paid to non-RENEW species? And what about non-COSEWIC species—the lowly invertebrates and non-vascular plants? Fortunately there are people interested in all these taxonomic groups.

The St. Lawrence Beluga (*Delphinapterus leucas*) in Québec, the Right Whale (*Balaena glacialis*) off the east coast, and the Sea Otter (*Enhydra lutris*) in British Columbia, all of which are marine mammals, have their champions. Along the west coast, Sea Otters were once numerous but the last individual was shot in 1929. Between 1969 and 1972 (again, before both COSEWIC and RENEW), scientists from the Pacific Biological Station released 89 otters from Alaska in an area off the west coast of Vancouver Island. Now there are over 300 Sea Otters in British Columbia's waters. A group of Québec scientists and citizens are studying problems faced by Belugas in the extremely polluted St. Lawrence River. Aided by Québec conservation groups, the St. Lawrence National Institute of Ecotoxicology, WWF, Canada and the Canadian Nature Federation (CNF), they are seeking to establish a marine park to protect Beluga habitat. Without waiting for RENEW to extend its mandate to include fish and marine mammals, the Department of Fisheries and Oceans (DFO), as the agency responsible for these species, has begun to work on their recovery. As the recovery plan format is working quite well, DFO is basing its efforts on the RENEW pattern.

The invertebrates are a lot less fortunate. They are not valuable as game species, and most are not well loved by the general public. However, even here, some taxonomic groups have found champions. Butterflies, perhaps because many are quite showy, have been the centre of considerable attention.

The Monarch Butterfly (*Danaus plexippus*), though in no danger in Canada, is vulnerable on its wintering grounds. Consequently, Canadians, including the CNF, have been working with Mexicans to ensure that important wintering habitat is preserved. A major travelling exhibit on this fascinating species is currently being produced by the Canadian Museum of Nature, the CNF, and a Mexican conservation group called Monarca A.C. Another example closer to home is that of the Karner Blue (*Lycaeides melissa samuelis*). A CNF affiliate, the Lambton Field Naturalists, raised money to buy critical habitat of this species in southern Ontario. Other examples of local groups, and even individuals, helping endangered species can be found. In many cases, these efforts are effective because the people involved are very close to their subjects and know exactly what is required.

However, a chronic lack of funding for such projects can be crippling, or render efforts useless. In recognition of this fact, Environment Canada and WWF Canada joined forces and contributed $1 million each to create the Endangered Species Recovery Fund. This fund, administered by WWF Canada, is used to assist in practical, applied work towards the recovery of endangered plants and animals native to Canada. It is not limited to species covered by COSEWIC or RENEW. Priority of funding depends on the national significance of projects, based on the degree of threat, taxonomic uniqueness, geographic distribution, and potential for recovery. Applicants for funds must normally be affiliated with a NGO, however, direct funding of individuals or companies may be considered in some cases. As of February 1992, the Endangered Species Recovery Fund has funded more than 76 projects across Canada. Although this program has been successful, there is a need to streamline the allocation of funds and develop a proactive manner to identify priority projects.

CONCLUSION

It is evident that a great deal is being done for endangered species, but this does not mean that we can relax. In fact, there is a lot of room for improvement, and many species still await attention. In Canada, while we are lucky enough not to be losing species at this time, we must remain vigilant and ensure that the less popular groups are also looked after so that all Canadian wildlife—all wild species—continue to exist. We must also work very hard to prevent species from becoming endangered. In other words, prevention is still far better than cure.

ACKNOWLEDGMENTS

The first author wishes to acknowledge the financial contribution of the Fondation pour la Sauvegarde des Espèces Menacées to the preparation of this manuscript. Dr. Don E. McAllister provided useful comments to the authors.

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A PROPOSAL TO INCORPORATE MULTI-SPECIES PROGRAMMING INTO THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN IN ALBERTA

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PREAMBLE

The North American Waterfowl Management Plan (NAWMP) was signed in 1986 by the governments of Canada and the United States, thereby, agreeing to cooperate in an effort to restore waterfowl populations to the long-term average as exemplified by numbers in the 1970s. The plan encouraged the formation of joint ventures to carry out this ambitious conservation effort. The largest and most important of these was the Prairie Habitat Joint Venture, most commonly referred to as the PHJV.

The PHJV consists of members from the governments of the three prairie provinces, Environment Canada, Agriculture Canada, Ducks Unlimited (DU) Canada, Wildlife Habitat Canada (WHC), and the North American Wildlife Foundation. Responsibility for implementation of the plan was assigned to the Provincial Implementation Groups in each province, resulting in the formation of the Manitoba Habitat Heritage Corporation, Saskatchewan Wetland Conservation Corporation, and the Alberta NAWMP Centre.

The Alberta NAWMP Centre was established to coordinate the implementation of the NAWMP in Alberta, on behalf of all its partners: Alberta Forestry, Lands and Wildlife, Canadian Wildlife Service (CWS), DU Canada, Alberta Agriculture, and WHC. The following proposal is an initiative of the Centre and has been approved by the Alberta Board of Directors to whom the Centre is responsible.

INTRODUCTION

Background

Implementation of the NAWMP on a provincial basis began in 1991 with major projects in the prairie, aspen parkland, and peace parkland biomes of Alberta. Responsibility for planning and delivery of the proposed programs rested with the Biome Delivery Groups established for this purpose in each project area. These groups provide the partners with a mechanism for transmitting input and concern directly into the project at the proposal stage. This structure is currently working satisfactorily with respect to waterfowl species but has not been effective in addressing non-waterfowl species concerns and incorporating these concerns into the project proposals. The need, therefore, to formalize a multi-species program was eminent.

Recently, it has become abundantly clear that the United States Fish and Wildlife Service and the Canadian partners are all committed to broadening the scope of NAWMP to include the host of other species associated with wetlands, riparian, and upland habitats as well as those listed as vulnerable, threatened, and endangered. The original 1986 NAWMP documents referenced other species as follows: "Although other wildlife species are not addressed in this plan, many are associated with water and wetlands and must be considered in developing operational plans for habitat preservation." A recent draft of the NAWMP Addendum 1992 states, "The focus of the plan has been broadened to include greater support for wetlands values and species diversity."

"Broadening the scope," it appeared, meant more than just describing or listing species that may derive benefit from NAWMP programs; partner agencies would like to see projects which include development/enhancement/management of habitat for the wide range of species associated with NAWMP in Alberta. This includes expenditures to secure, develop, or manage habitat for these species.

The purpose of this proposal, therefore, is to describe the objectives and the procedures for implementation of a multi-species program for NAWMP in Alberta.

Objectives

The following summarizes the overall objectives for the multi-species program of the NAWMP in Alberta:

1. To identify and review the needs, opportunities, and priorities for migratory and native species with

respect to land management programs as part of NAWMP delivery in Alberta.

2. To determine and document the impact on wildlife species resulting from the full range of ongoing NAWMP land management options.

3. To ensure that delivery of NAWMP activities does not negatively impact other wildlife species.

4. To be aware of the habitat requirements of vulnerable, threatened, or endangered species within the identified NAWMP landscapes and to incorporate these needs into the landscape plans in conjunction with program delivery.

5. To establish an appropriate mechanism for incorporating multi-species land management programming into existing ongoing projects in Alberta. Of particular importance is the need to resolve situations where there are substantial benefits to other species but only moderate or minimal waterfowl benefits.

6. To identify and foster partnerships with other Canadian and United States agencies that may wish to cost share multi-species aspects of the NAWMP program.

7. To heighten the awareness and profile of multi-species benefits of NAWMP programming in Alberta through communications programs.

PROCEDURE

The Alberta NAWMP Centre will assume overall responsibility for directing the multi-species program in Alberta. A team of NAWMP employees will be established to carry out the above stated objectives. Team members will report directly to the Centre. The following outlines structure and responsibilities of the multi-species component in Alberta.

Alberta NAWMP Centre

- Responsible for overall program content, staff assignment and supervision, and budget allocation and approval.

- Responsible for maintaining liaison with Biome Delivery Groups and other partner agencies.

- Responsible for developing terms of reference, appointing members, and maintaining liaison with the NAWMP Multi-Species Technical Advisory Committee.

- Responsible for liaison with the Alberta Board of Directors, the PHJV Advisory Board, and other provincial coordinators.

- Responsible for communications related to the multi-species program.

Multi-Species Team Members

- NAWMP staff knowledgeable in multi-species aspects have been assigned to the team in each of the major biomes although members may be given work outside those biomes. The existing NAWMP Resource Specialists have undergone a reallocation of their work plans to allow more time to be spent on multi-species programming. The following team members will devote a significant percentage of their time to this project: Ernie Ewaschuk, Team Leader, Senior Project Biologist (Edmonton); Reg Arbuckle, NAWMP Resource Specialist (Grande Prairie); Andy Murphy, NAWMP Resource Specialist (Red Deer); Tom Sadler, Wildlife Biologist, NAWMP (Strathmore); Bob Goddard, NAWMP Resource Technician (Lethbridge). The team's mandate is as follows:

- Responsible for identifying status and habitat requirements of non-target species in the current and future landscapes of NAWMP land program delivery.

- Responsible for ensuring the above data are made available to the Biome Delivery Groups for incorporating into the landscape plans.

- Responsible for establishing a process for incorporating multi-species into the landscape plans including: inventory information, approval criteria, and development/enhancement techniques.

- Responsible for establishing and maintaining liaison with Biome Delivery Groups, local and regional naturalist/interest groups, and other related government/non-government agencies.

- Assisting in the development and delivery of the multi-species communications program.

NAWMP Multi-Species Technical Advisory Committee

The main objective of the committee will be to provide technical advice to the Alberta NAWMP Centre with respect to the implementation of the multi-species program in Alberta. The committee will be chaired by the Alberta NAWMP Centre. Membership will consist of individuals knowledgeable in technical aspects of all species associated with NAWMP programming. Other experts or agencies may be called in as required to deal with specific situations or species. The committee will review proposals put forth by the Centre and make recommendations related to the priority and technical aspects of proposals. The committee may recommend projects, provide species priorization and/or identify areas that require research. The committee may recommend funding sources available to assist in the multi-species program.

PROJECTS UNDER WAY OR IN PROPOSAL STAGE

Piping Plover (*Charadrius melodus*) habitat study in relation to the 1991 International Census is currently in progress with funding from Alberta NAWMP Centre. A proposal has been submitted to CWS, to cooperate in gathering census information on shorebird migration and breeding related to large marshes identified in the Alberta plan (NAWMP). Two proposals are underway to secure Piping Plover habitat in east central Alberta, in relation to NAWMP landscape planning. Finally, a proposal is being developed to assess the effects of NAWMP land treatments on non-target wildlife species. The study will compare treated and untreated landscapes.

LANDSCAPE ECOLOGY, ADAPTIVE RESOURCE MANAGEMENT, AND THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN

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INTRODUCTION - THE AGRICULTURAL ROOTS OF WILDLIFE MANAGEMENT

The science of wildlife management and that of ecology developed historically along different lines (Nudds 1979, 1988). Wildlife science tended toward the study of wild populations of single species with the (often implicit) goal of understanding how to manipulate some of them to achieve greater yields. Definitions of "wildlife management" in recent textbooks evolved little from Leopold's (1933) original: the sustained production of annual crops of wild game (Nudds 1988). Close academic links between wildlife management and agriculture (Table 1) contributed to the notion that, as in agriculture, high-yielding crops of harvestable wildlife could be achieved through the application of improved technology. To be fair, there has been for a long time in wildlife management circles the idea that not to manipulate wildlife constitutes conscious management, and managers are concerned increasingly with non-game wildlife without the goal (explicit or implicit) of producing high yields for harvest (e.g., Capen 1989). Nevertheless, production remains a cornerstone of wildlife management, as does the idea—in some circles—that to achieve it requires intensive, high-material-input (HMI) techniques.

Wildlife managers developed expertise in data acquisition (McCabe 1985: 338) and a "practising knowledge" based on empiricism, but wanting for theoretical frameworks both to guide the collection of data and to interpret it (Fretwell 1972, Sinclair 1991). Conversely, ecological science tended toward explanations for why populations fluctuate and focused greater attention to interactions among species, to communities, and to ecosystems than did wildlife management (Nudds 1992), but it tended also to develop theory wanting for empirical evaluation (Nudds 1979).

Events of the last couple of decades are causing wildlife managers to rethink some of the implicit assumptions about the goals and practices of management (e.g., Capen 1989). For instance, landscape ecology (Naveh and Liebermann 1984, Forman and Godron 1986) and conservation biology (Soulé and

Table 1. The distribution of Canadian and American universities with and without undergraduate programs in agriculture and wildlife biology. The sampling universe for American schools (n = 106) was all private (e.g., University of Washington) and public (e.g., Washington State University) universities listed in Furniss (1973). Information about Canadian schools (n = 48) was obtained from various university calendars. Overall, there is a strong dependence of the presence of wildlife programs on the presence of agricultural programs ($\chi^2 = 19.6$, $p < 0.005$). The effect is significant within countries also (American schools: $\chi^2 = 13.02$, $p < 0.005$; Canadian schools: $\chi^2 = 10.3$, $p < 0.005$). Many schools have neither type of program. Many more have agriculture programs without wildlife biology programs, but the reverse is seldom true; in eight of those 10 cases the "agriculture" program present is one in forestry and silviculture. These data indicate that the influence of agricultural thought on philosophies about wildlife management is likely to run deep in academic curricula.

	Agricultural Program	
Wildlife Program	Present	Absent
Present	34	10
Absent	34	76

Wilcox 1980, Soulé 1986) came of age. Among the goals of landscape ecologists and conservation biologists is greater synergism between "pure" and "applied" research. There is increased attention among wildlife managers to merge theory with practice (Romesburg 1981, Nudds and Morrison 1991) and to manage wildlife by conducting management as experiments (McNab 1983, Sinclair 1991, Walters and Holling 1990). Further, there is growing awareness that some HMI agriculture may undermine the sustainability of agricultural systems (Ehrenfeld 1987, Jackson and Piper 1989). Ironically, although wildlife managers have long vilified intensive agriculture as a cause of habitat destruction, some intensive, HMI-style wildlife management may no more contribute to the long-term sustainability of wildlife than will some intensive farming contribute to the long-term sustainability of agriculture.

In this article, we build a brief history of the demise of the productivity of both agriculture and waterfowl on the Canadian prairies. We outline why there is an opportunity to reverse these declines through cooperation, rather than conflict, between agriculture and wildlife interests, and why the North American Waterfowl Management Plan (NAWMP) became the culmination of activity by proponents who recognized that opportunity. We then briefly contrast two schools of thought about what kind of wildlife management techniques—intensive (i.e., increasing duck production on small tracts of land) or extensive (i.e., affecting broad-scale changes to the landscape)—ought to be used to rebuild declining populations. We follow with a brief review about what is known about the prospects for success by either approach and conclude that, in spite of a great deal of information about ducks, we currently have insufficient knowledge to deem any one approach better than the other for reversing population declines. We finish with a suggestion that managers implement projects in ways that can be evaluated to test among the competing approaches—in effect, to do management by experiment (McNab 1983, Sinclair 1991)—and give the "flavour" of one experimental design that might accomplish that.

DECLINE OF AGRO- AND NATURAL ECONOMIES IN THE PRAIRIES

The prairie ecosystem supports two kinds of economies; the long-term sustainability of both are in jeopardy. Policies to encourage grain production, even on marginal land (Figure 1), made economic sense when Canada was virtually the sole supplier of grains to the

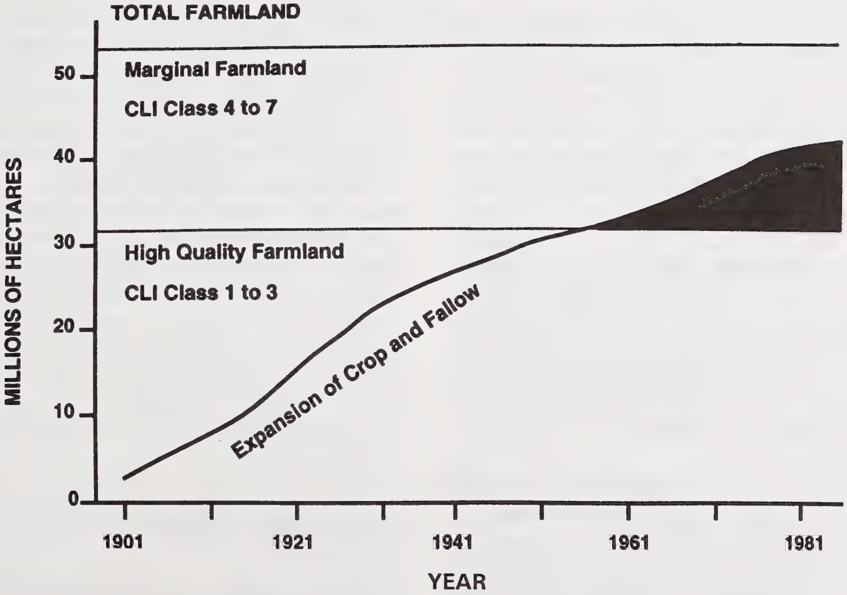

Figure 1. The expansion of "improved" agricultural land in prairie Canada. In many areas, the best quality land was occupied by about the late 1950s; agricultural expansion since has been largely onto marginal, lower-quality land which is more costly to farm (courtesy J.H. Patterson, unpubl. data).

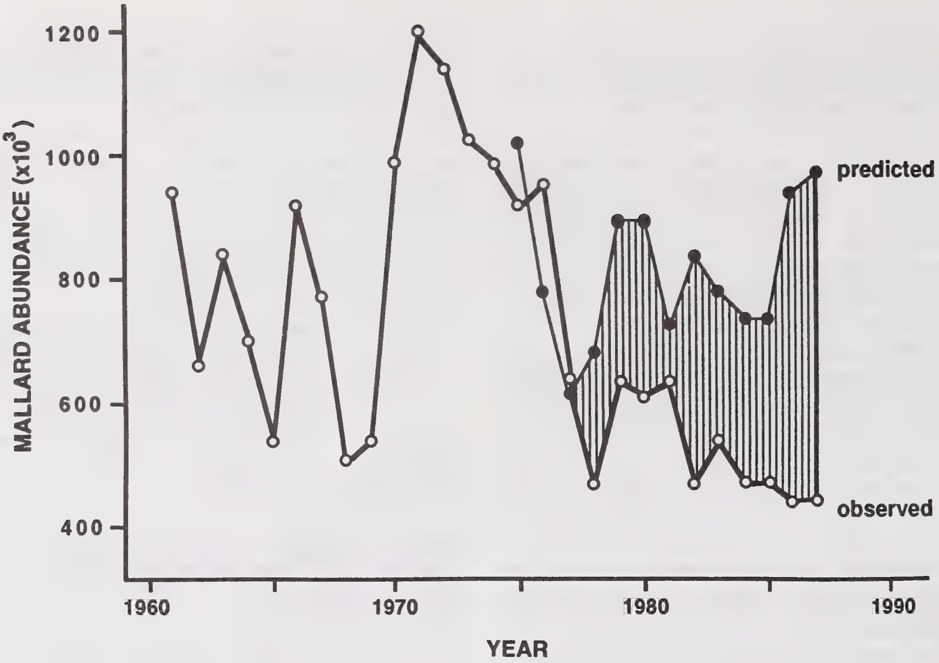

Figure 2. The observed and predicted abundances of Mallards in a part of southeastern Alberta. The predicted abundance is based on the relationship between precipitation and Mallard abundance prior to 1975, when the two fluctuated closely (Bethke and Nudds, in press).

world. However, economic and ecological developments have caused hardship for grain farmers. Former grain customers became self-sufficient and began to compete in world markets, and sustained price wars led to prices for Canadian grain too low to meet rising costs of production. For a time, governments tried to cover the shortfalls but persisted nevertheless with policies that encouraged marginal land conversion to "improved" agricultural land and greater production. Reductions in yields during the dry years of the 1980s exacerbated the problem, so that between 1981 and 1991, the proportion of prairie farmers' incomes supplied by subsidies had increased to as much as 80 percent. Governments have been forced to reduce commodity support subsidies, further increasing economic hardship among prairie grain producers.

Over the same period, wildlife interests documented the decline of the natural economy of the prairies—in some areas, the complete disappearance of some species, and the decline of others. Many of Canada's rare, endangered, and threatened nongame wildlife are in the prairies. Since the mid-1970s, populations of Mallards (*Anas platyrhynchos*) (Johnson and Schaffer 1987), Northern Pintails (*A. acuta*), and Blue-winged Teal (*A. discors*) have declined to levels below even that which existing wetlands can support, or which precipitation levels predict ought to be present (Figure 2; Bethke and Nudds, in press). This is inconsistent with the notion that climate is responsible for the declines in duck populations. Rather, it appears that some anthropic agent, like changes to nesting habitats that decrease breeding success, over-winter mortality, or both are to blame. However, because neither population sizes nor breeding success of Mallards and Northern Pintails in boreal forest (where agriculture is absent but ducks are still hunted) appear to have declined over 30 years, it seems that changes to the prairie landscape (Figure 3) may have been relatively more important than events away from breeding areas as causes of declines of prairie ducks (Nudds and Cole 1991).

THE EMERGENCE OF THE NAWMP

On the assumption that habitat loss was responsible for declines in duck populations, and because there was a "window of opportunity" to affect change to agricultural policy during difficult economic times on

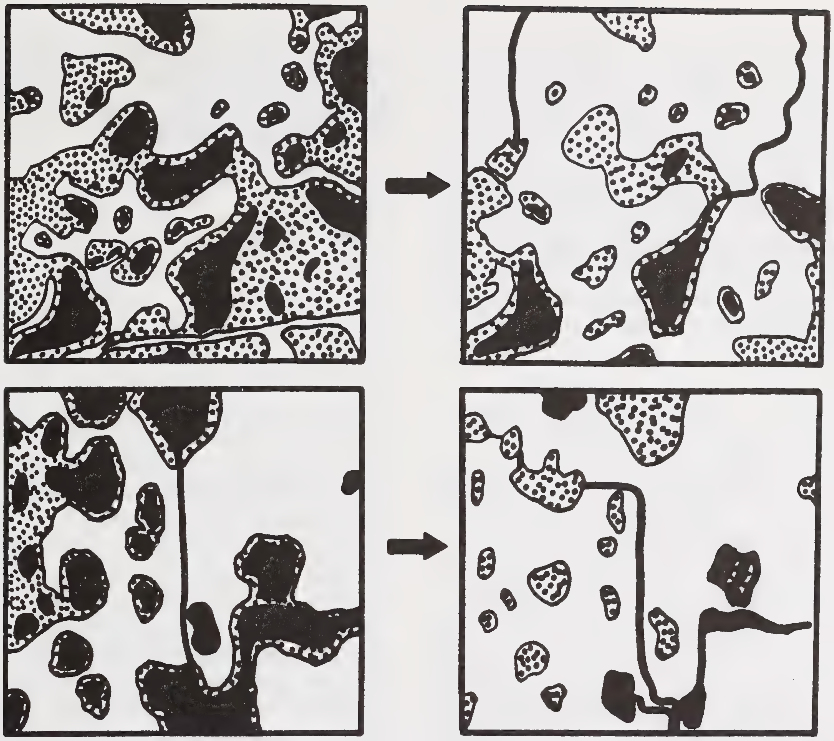

Figure 3. Changes over 10 years on two sections of agricultural land in Saskatchewan aspen parkland. Strippled areas represent natural habitats, dark areas are wetlands, and white areas are cropland (after Adams and Gentle 1978).

the prairies, Canada and the United States initiated NAWMP in 1986. The NAWMP expanded quickly to include proposals to protect and manage wintering grounds as well as breeding grounds, but a principal focus remained that aspect of the plan that dealt with breeding areas in intensively-farmed prairie Canada, the Prairie Habitat Joint Venture.

Some agricultural interests, like Agriculture Canada, contributed early to the plan, realizing the logic to the argument that ducks and grain were dependent on the same requisites. Ducks and grain required water, and some agricultural practices were inefficient at conserving it, ultimately, to the detriment of both. Further, some soil management practices were causing soil losses through wind erosion; and ducks might find adequate nesting habitat if the establishment of permanent cover on erodible soils was encouraged. With grain prices low, recovery of marginal land that was too costly to farm should be possible. Other wildlife would benefit. NAWMP was conceived and sold on the idea that, through a landscape-ecological approach, it might be possible to put both the agro- and natural economies of the prairies back on a sustainable footing.

TWO SCHOOLS ABOUT RESTORING DUCK POPULATIONS: MANAGING FOR DUCKS OR MANAGING FOR LANDSCAPES?

A goal of the NAWMP is to restore duck populations to sizes that will fluctuate near mid-1970s levels (on the assumption that these sizes approximate the long-term averages of extremely variable populations), but another view developed about how to achieve it. Frustration that had developed while wetlands were drained, and marginal land converted to cropland, dampened enthusiasm among some wildlife managers for the notion that cooperation with agriculture, rather than conflict, might lead to recovery of duck populations.

Some argued that the recovery of land in amounts that would matter was impossible, so the alternative to compensate for habitat losses was to manage for increased duck production in remnant parcels of habitat, or to create small, intensively managed parcels for duck production in agricultural landscapes. This view continued the tradition of considering the purpose of research and management on ducks to be "to grow two where only one grew before" (Green et al. 1964: 568). Others viewed intensive management as an interim measure because landscape modification was going to take a long time.

Proponents of both extensive and intensive management accepted that a major factor contributing to duck declines was low hatching rates of nests due to high rates of predation. Habitat alteration is thought to force ducks to nest in small, remnant patches of habitat (Figure 4) where they may be more vulnerable to nest predators (see review by Clark and Nudds 1991). Prairie settlement also brought changes to the composition of predator communities, from those dominated by predators that did not prey extensively on ducks and their nests to those that do (Johnson and Sargeant 1977). Further, proponents of each approach agreed with the implicit assumption that nest survival was an important "bottleneck," and that populations could be augmented by reversing a presumed historical decline in nest success. However, past this general agreement there was little other.

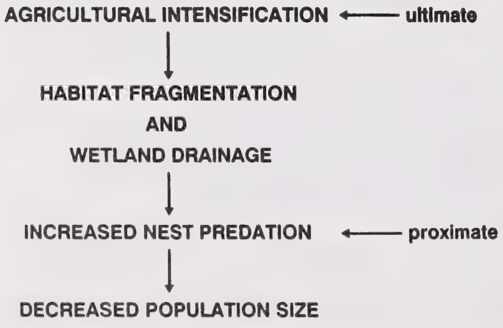
AGRICULTURAL INTENSIFICATION
ultimate
HABITAT FRAGMENTATION AND WETLAND DRAINAGE
INCREASED NEST PREDATION
proximate
DECREASED POPULATION SIZE

Figure 4. "Levels of causation" for factors hypothesized to cause declines in prairie ducks.

OVERVIEW OF EVIDENCE ABOUT THE EFFECTIVENESS OF INTENSIVE AND EXTENSIVE MANAGEMENT

The intensive school offered that either removal of nest predators, or deterring them with some combination of plantings of dense nesting cover (DNC) (Duebbert 1969, Duebbert and Kantrud 1974), perhaps also with electric fences (FDNC) (Duebbert and Lokemoen 1980, Lokemoen et al. 1982), would augment nest success. This view assumes that: 1) nest success, in fact, declined over time (Beauchamp et al., submitted manuscript); and 2) increasing it should translate into increased "recruitment," at least to the fall population, while acknowledging that little is known about duckling survival, fledging success, overwinter survival, and homing to natal sites (that is, recruitment to the breeding population; e.g., Anonymous 1987, Cowardin et al. 1988). However, although a recent review of the evidence for a decline in nest success indicates that it has (Beauchamp et al., submitted manuscript), the evidence about the effect of predator fences and/or removals (Greenwood et al. 1990) and DNC plantings (Clark and Nudds 1991) on nest success is equivocal and the effects unpredictable (Beauchamp et al., submitted manuscript).

Proponents of extensive management also proposed that nest predators be deterred through habitat manipulation, but indirectly, and pointed out that trying to affect change in a proximate cause of population declines without affecting the ultimate one (Figure 4), would only be treating the symptoms of the ailment. Management to alleviate nest predation at the proximate level might be (at most) fortuitous or (at best) expensive and ongoing, requiring continuous input of capital and personnel. Proponents of extensive management argued that large-scale restoration of marginal land should enable ducks to disperse nests at low densities which should lower the foraging success of predators. Management focused at the ultimate cause could prove to be a less costly solution in the long run, and might benefit agriculture as well as waterfowl. This could be achieved principally through changes to agricultural policy—in particular, the conversion of commodity-support subsidies to conservation-support subsidies. Finally, proponents of extensive management argued that proponents of intensive management had not realistically considered the long-term costs of intensively rearing ducks, even if it could be shown that the assumptions on which it was predicated were correct and that intensive techniques consistently "work." The NAWMP amounts to a subsidy to produce ducks; its lifetime is projected to be 15 years. At that time, it would disappear, leaving duck populations with no habitat base to sustain them and managers with an infrastructure too costly to support.

Extensive landscape management to affect changes to nest success (and recruitment) is not without its own problems. As outlined above, it is not clear how much of observed declines in breeding populations might be due to events during the breeding season, or to events in areas away from breeding habitats (or both). Further, a recent review by Clark and Nudds (1991) concluded that nest success is not consistently greater on larger areas of habitat. They hypothesized that the degree to which nest success varies with patch size might itself vary inversely with the degree of degradation of agricultural landscapes (Figure 5). Nest success may be lower over all patch sizes in severely degraded landscapes than in moderately degraded landscapes because absence of alternative nest sites, and fewer patches, may concentrate more ducks (resulting in inverse density-dependence in nest success due to crowding) or more predators (resulting in positive density-dependence in nest loss) in and/or around each patch. They concluded that "until the relationships among habitat patch size and duck nesting success are determined empirically, ...debate over the relative cost-effectiveness of different waterfowl nesting habitats will remain conjectural" (Clark and Nudds 1991: 538). A controlled experiment, conducted as part-and-parcel of ongoing management programs (McNab 1983, Sinclair 1991, Clark and Nudds 1991), is necessary to decide the relative importance of the confounded factors affecting nest success and recruitment in prairie ducks and allow managers to choose among competing proposals (intensive versus extensive), or an appropriate mix, to augment them.

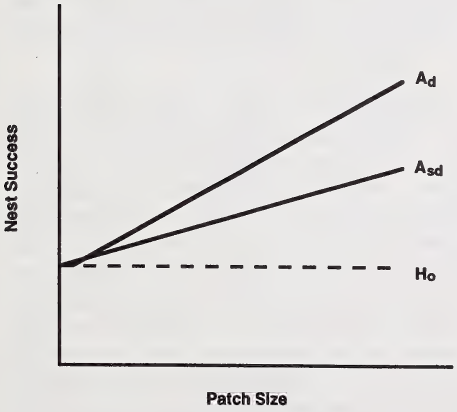

Figure 5. The hypothesized effect of patch size on nest success (proportion of nests that hatch successfully) of ducks in habitat patches. H_o is the relationship predicted by the null hypothesis. A_d is the relationship predicted by the alternate hypothesis in degraded landscapes, and A_{sd} is that predicted for severely degraded landscapes.

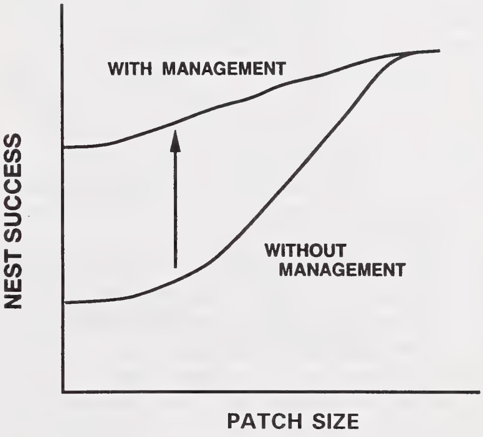

Figure 6. Nest success may vary with patch size naturally. The purpose of predator management is to try to augment nest success on especially small patches.

AN EXPERIMENTAL PROTOCOL TO TEST BETWEEN INTENSIVE AND EXTENSIVE MANAGEMENT TO INCREASE DUCK POPULATIONS

Nest success can vary with the size of the tract of land (patch) upon which it is measured (Clark and Nudds 1991, but see Clark et al. 1991, Higgins et al. 1992) (Figure 6), but it is sometimes high on small tracts (Gatti 1987) with intensive management (e.g., Greenwood et al. 1990). So, increased nesting success might be achieved by either direct, intensive predator management or indirect predator management through extensive landscape management, but there is conflicting evidence for each. From a management perspective, the questions remain: 1) can intensive predator management such as fenced enclosures and dense cover plantings consistently increase nest success or recruitment and, if not, why not?; 2) are intensive management techniques equally effective over a range of patch sizes?; 3) if not, is there some patch size above which no intensive management will return more, in terms of nest success or recruitment, for the investment than extensive landscape management alone?; and 4) which of the intensive (predator management) or extensive (landscape management) options is most cost-effective over the long-term?

The answer to the last question cannot be known until there are answers to the others (Figure 8). To get the answers requires that management be conducted as experiments (MacNab 1983, Walters and Holling 1990). The simplest of such experiments could be designed to be analyzed by regression with a treatment, a control, and patch size as a covariate (Figure 7). Figure 7 shows recruitment to the breeding population (i.e., ducklings that survive to reproduce) plotted against size for each of control (CON) patches and, say, patches of FDNC. Two points need to be made about the figure. First, only linear relationships with positive intercepts are plotted. More realistically, the curves might pass through the origin and be convex downward because, at one extreme, there can't be ducks breeding on zero land and, at the other extreme, there must be some upper limit to recruitment. Because the shapes of the curves do not affect the argument for the need for an experiment, the case with linear relationships is presented for simplicity.

Second, even if high nesting success is achieved among crowded nesting populations on small plots, inverse density dependent processes (lowered growth and survival) among ducklings might mean that no net recruitment occurs to the fall population, let alone the breeding population (Clark and Nudds 1991). So, nest success may not be an appropriate response variable for gauging the efficacy of intensive management designed to increase breeding populations. For simplicity, the experiment is outlined using recruitment as the relevant response variable, though it would be informative to measure other variables at several points in the annual cycle, such as egg success, nest success, and duckling survival, to test if and when density-dependence is manifested (Hill 1984).

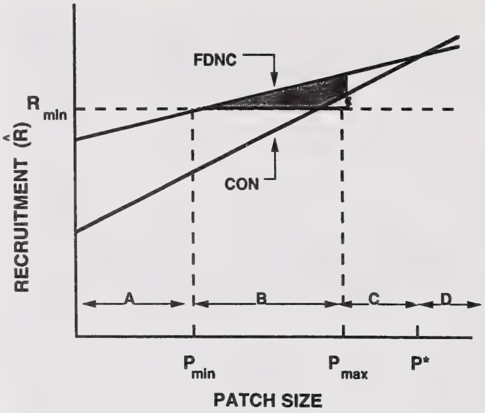

Figure 7. The feasibility of managing predators to increase duck populations depends on whether, and how, recruitment (to the breeding population) from habitat patches of various sizes varies with predator management.

Let R_{min} be the minimum recruitment rate to maintain a breeding population of ducks (Figure 7). The NAWMP requires that this level is exceeded, since the goal is to increase duck populations and not just maintain them. Suppose that R (observed recruitment to the local breeding population) varies with patch size on unmanaged CON patches and can be further increased in FDNC. Whether FDNC is actually better than CON, of course, can be determined by the experiment, as can the exact shape of the curves.

The best management option in the example depicted in Figure 7 depends on the constraints. P_{min} is that patch size below which no intensive predator management pays, nor which is worth acquiring (if the objective is to increase R). In region A, no patch size, even with management, is worth acquiring. If the maximum land parcel available (P_{max}) is smaller than P* (that patch size above which intensive predator management cannot augment recruitment better than that which can be achieved in large, unmanaged patches alone), then the management option ought to be the cheapest alternative within the shaded feasibility region B. For instance, the largest P with FDNC may be too expensive, but at least all combinations of P and FDNC within the shaded region should increase R and the population. Which is the "best buy" will depend on land, material, and labor costs amortized over an appropriate time period. In region C, predator management should still return more than increasing patch size alone, but constraints (P_{max}) on the maximum

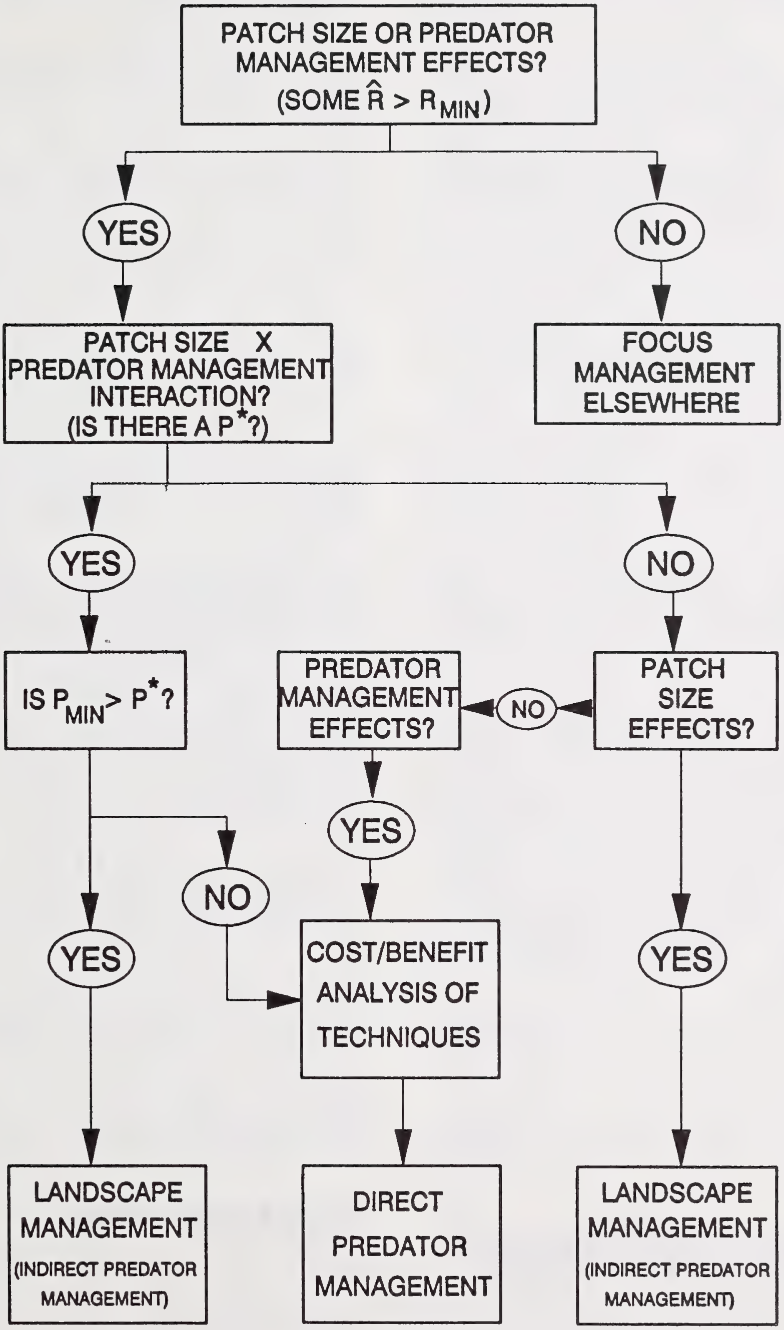
PATCH SIZE OR PREDATOR MANAGEMENT EFFECTS? (SOME $\hat{R} > R_{MIN}$)
YES
NO
PATCH SIZE X PREDATOR MANAGEMENT INTERACTION? (IS THERE A P^*?)
FOCUS MANAGEMENT ELSEWHERE
YES
NO
IS $P_{MIN} > P^*$?
PREDATOR MANAGEMENT EFFECTS?
NO
PATCH SIZE EFFECTS?
YES
NO
YES
COST/BENEFIT ANALYSIS OF TECHNIQUES
YES
LANDSCAPE MANAGEMENT (INDIRECT PREDATOR MANAGEMENT)
DIRECT PREDATOR MANAGEMENT
LANDSCAPE MANAGEMENT (INDIRECT PREDATOR MANAGEMENT)

Figure 8. A simple flow diagram to decide among intensive versus extensive alternatives for managing predation on duck nests.

patch size available limits feasibility. Here, no management is possible. If, however, patch size is not constrained by availability or money to sizes below the point at which recruitment is not greater in predator-managed patches than it is in patches with no predator management (P*), then there are diminished returns to investment in intensive predator management (region D). FDNC will never contribute more to recruitment than will a large, unmanaged patch alone; in that case, a landscape ecological approach to management should prove to be better for increasing duck populations. P* is, therefore, an estimate of the minimum patch size needed to reduce the long-term costs of intensive predator management to zero with no reduction in benefits (sustainable duck populations).

If R doesn't vary with P, especially such that it never exceeds R_{min}, neither intensive management nor the landscape option will ever increase population size. Any results like these would imply that conditions on breeding areas do not limit population size and other hypotheses (overwinter mortality, cross-seasonal effects of wintering ground conditions on breeding success) might need to be invoked to account for declines of prairie-nesting ducks (see Nudds and Cole 1991).

The patch sizes employed need not encompass that which gives R, R_{min}, nor P*; as long as R (or some other relevant measure of contribution to a sustainable breeding population) varies with P, sufficient replicates should allow prediction of both P at which R, R_{min}, and P* (Figure 7). Especially to allow prediction beyond the range of patch sizes included in the experiment, there would need to be sufficient replicates (randomly distributed with respect to water regimes and land uses) of treated and control patches over the widest possible range of sizes. Further, the experiment should be replicated in a minimum of two places, because composition of the guild of nest predators differs in different parts of the prairies, and predator management might work better in areas with highly degraded landscapes (like prairie) and landscape management in others, perhaps with less degraded landscapes (like aspen parkland).

MANAGEMENT IMPLICATIONS FOR LANDSCAPE ECOLOGY

Recruitment of ducks to breeding populations is the product of an array of dynamic processes, but many of these are poorly understood and poorly quantified. Until these basic research questions are addressed, the impact of breeding habitat manipulations on duck populations will remain unclear. However, there is no need to curtail management while research proceeds. Instead, we advocate that management proceed by designs that will simultaneously allow for these research questions to be addressed.

In practice, whether management of the landscape is feasible will depend on the willingness of landowners to sell or lease land, and cost. However, our experimental protocol might contribute to resolving unanswered questions about the efficacy of intensive versus extensive management. At any rate, treated as just a simple "thought experiment," this exercise is beneficial if only because it aids in pointing out the complexities involved, and in establishing the severely constrained conditions under which intensive, traditional predator management techniques might be expected to be successful. It also serves to point out that, until questions are answered about whether intensive management is likely to achieve the long-term objective of increasing population size at all (Figure 8), it may be premature to engage in discussions about which of the intensive management techniques is most cost-effective (Lokemoen 1984). The exercise further suggests that a landscape approach may prove more likely to achieve the goals of the NAWMP because such an approach should, at least, address the problem of low duck populations at its source (landscape degradation), thereby treating the ailment rather than merely the symptoms of it.

ACKNOWLEDGMENTS

Lots of people, some because they agree with us and some because they do not, have contributed over several years to, and encouraged the development of, the ideas presented here. We would, however, especially like to thank J.H. Patterson, A.W. Diamond, R.T. Alisauskas, R.W. Bethke, J.M. Fryxell, T.W. Arnold, G.A. Surgeoner, and M.R. Moss for discussion and comments on earlier drafts. This work is partially funded by the Natural Sciences and Engineering Research Council grant (A7757) to T.D. Nudds.

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THE EFFECTS OF HABITAT PATCH SIZE ON AVIAN COMMUNITIES IN ASPEN PARKLANDS

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The following text is a summary from Johns (in press).

INTRODUCTION

The aspen parklands is a transition zone between boreal forest and grassland. Diversity of avian species and abundance of individuals in Aspen (*Populus tremuloides*) are generally higher than in most other habitats, except perhaps mixedwood forest. This diversity may be partly related to the ecotonal nature of the parklands.

The productivity of parkland soils for agriculture has encouraged intensive cultivation which has significantly altered the parklands, grasslands have been cultivated, aspen groves cleared, and wetlands filled or drained.

The objective of this study, was to determine the relationship between aspen grove size and bird species richness in agricultural land within the aspen parklands of central Saskatchewan.

STUDY AREA

The study was conducted near Saskatoon, Saskatchewan. Twenty-seven aspen groves, 0.04 ha to 36.7 ha in size, were randomly chosen.

METHODS

I used a modified point count to census birds. Three 20 minute visits were made to every point, in each of the three breeding seasons (May 26 to July 4 of 1984, 1985, and 1986). I measured isolation of each grove from its nearest neighbour and from the nearest large grove.

RESULTS

Area and Isolation

In my study area, small groves (less than 2 ha) were highly isolated from other groves, especially from larger groves (those greater than 2 ha). The large groves were in close proximity to other large groves.

Species Richness and Abundance

Fifty species of birds were recorded from the 27 aspen groves studied during the breeding seasons of 1984 (39 species), 1985 (42 species), and 1986 (46 species). Forty-one of those species had territories that were small enough to be restricted to the groves that they were recorded in. These species were used in the calculations of species richness.

The number of species, at each census point, increased with an increase in area of aspen grove. The number of individuals at each census point also increased with an increase in area of the grove.

Habitat Guilds

The number of edge (those species preferring the edges of aspen groves), interior/edge (those species occurring throughout the grove), and interior species (those species that occur only within the heart of larger groves) each increased with an increase in the size of the grove.

Foraging Guilds

There was no noticeable increase in omnivore species richness over the size range of groves studied, however, the number of insectivorous species increased dramatically with an increase in grove area.

Migratory Status

The number of species of long- and short-distance migrants and permanent residents each increased with an increase in the size of the grove.

Responses of Individual Species

Individual species' responses were calculated for 31 species of birds (Table 1). Fifteen of those showed a significant increase with an increase in grove area; one species, the Clay-coloured Sparrow (*Spizella pallida*), showed a significant increase with increased isolation while three other species demonstrated a significant negative trend with increased isolation; and one species (Least Flycatcher [*Empidonax minimus*]) was related to both area (+) and isolation (-).

SUMMARY

1. Aspen grove size influences the composition of the bird community. The abundance and diversity of avifauna were significantly correlated with grove size.
2. Species richness of edge, interior/edge, and interior species were each significantly correlated with area.
3. Species richness of insectivores was strongly correlated with area, whereas for omnivores it was not.
4. Migratory strategy was correlated with size of grove.
5. The densities of 15 species were correlated with area, densities of four species were correlated with isolation, and the density of one species was correlated with both.

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Table 1. Species relationships with area and isolation in Saskatchewan parklands, 1984 to 1986

Species that increased with increasing area	Species that increased (+) or decreased (-) with increasing isolation	Species that increased (+) or decreased (-) with increasing area and isolation
Mourning Dove (*Zenaida macroura*)	Veery (-) (*Catharus fuscescens*)	Least Flycatcher (*Empidonax minimus*) (+ area, - isolation)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Ovenbird (-) (*Seiurus aurocapillus*)	
Downy Woodpecker (*Picoides pubescens*)	Connecticut Warbler (-) (*Oporornis agilis*)	
Hairy Woodpecker (*P. villosus*)	Clay-colored Sparrow (+) (*Spizella pallida*)	
Great-crested Flycatcher (*Myiarchus crinitus*)		
Black-capped Chickadee (*Parus atricapillus*)		
House Wren (*Troglodytes aedon*)		
Cedar Waxwing (*Bombycilla cedrorum*)		
Warbling Vireo (*Vireo gilvus*)		
Red-eyed Vireo (*V. olivaceus*)		
American Redstart (*Setophaga ruticilla*)		
Rufous-sided Towhee (*Pipilo erythrophthalmus*)		
Vesper Sparrow (*Pooecetes gramineus*)		
Brown-headed Cowbird (*Molothrus ater*)		
Northern Oriole (*Icterus galbula*)		

HABITAT FRAGMENTATION AND BURROWING OWLS IN SASKATCHEWAN

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INTRODUCTION

The role of habitat fragmentation in the decline of North American forest birds has been recognized over the last 15 years (Terborgh 1989). However, the role that such fragmentation plays in the conservation of prairie birds is still quite unknown despite the fact that the Canadian prairie ecosystem is one of the most heavily fragmented in the world. With this in mind, I conducted a preliminary investigation into whether habitat area has any effect on Burrowing Owl (*Athene cunicularia*) numbers, occupancy, reproduction, mortality, and movements. The Burrowing Owl is designated as threatened in Canada and habitat loss has been identified as one of the primary factors influencing the decline of the species. Despite this, little is known about the effect of habitat fragmentation on Burrowing Owls.

METHODS

The data for this study were derived from two sources. Firstly, pasture size and occupancy by owls across southern Saskatchewan were obtained from Operation Burrowing Owl data files of the Saskatchewan Natural History Society (Palmer and Hjertaas 1991). Data for reproduction, mortality, and movements in relation to habitat area were obtained from an ongoing study of Burrowing Owls on the Regina Plain (James and Fox 1987, James et al. 1990, James et al. 1991).

RESULTS

Across southern Saskatchewan, a significant association (r = 0.17, n = 136, p = 0.05) was detected between the number of breeding pairs of owls over a 5-year period and the size of the pasture (Figure 1). However, it should be noted that while absolute numbers of owls increased on larger pastures, they existed at much lower densities due to the logarithmic nature

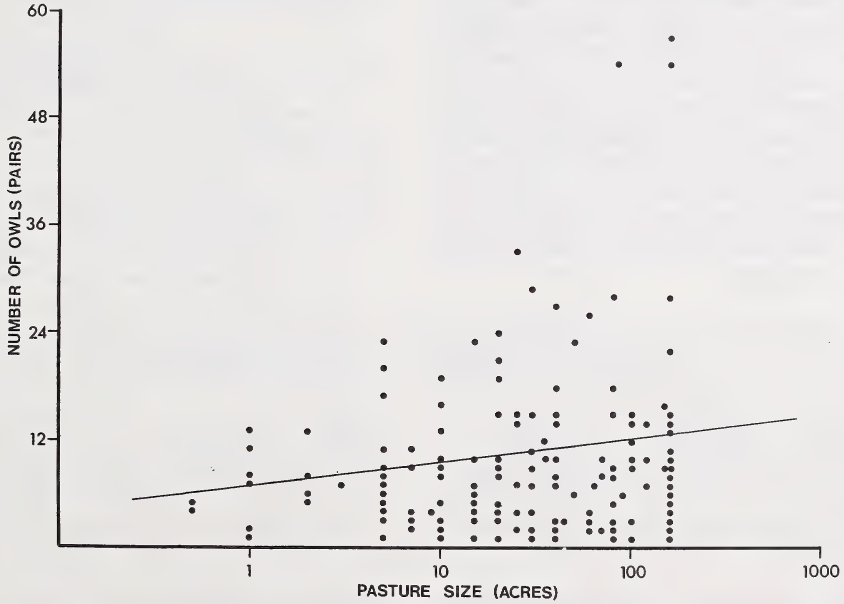

Figure 1. Number of Burrowing Owl pairs nesting over a 5-year period on pastures of different sizes. Operation Burrowing Owl data.

of the pasture size data. In addition, pastures that had been occupied for all five years were significantly (t test, p = 0.01) larger (mean 76.1 acres, median 65 acres, n = 54) than pastures that were occupied from one to four years (mean 47.5 acres, median 30 acres, n = 160).

On the Regina Plain study area, no significant relationships could be detected between pasture size and the proportion of nests that failed (r = 0.41, n = 15), the number of chicks produced by successful pairs (r = -0.23, n = 16), the survivorship of adults (r = 0.14, n = 11), or the survivorship of juveniles (r = 0.42, n = 9). However, the sample size of pastures examined was much smaller than that of Operation Burrowing Owl. Finally, there was no significant net movement of owls between different sized pastures between years. Ten adults or juveniles moved from smaller to larger pastures, and seven adults or juveniles moved from larger to smaller pastures.

DISCUSSION

Clearly, pasture size does have an effect on the number of Burrowing Owls present as well as on their length of occupancy (Figure 1). Larger pastures contain more breeding pairs and they persist longer. However, the relationship is a very weak one owing to a large number of larger pastures not having increased numbers of owls. In addition, the number of owls does not increase in direct proportion to increase in pasture size. In fact, to get a doubling in number of owls requires, on average, 100 times the amount of pasture assuming that the relationship is a linear one, which it may not be (Figure 1). No pastures over 160 acres were included in this analysis, probably owing to their relative scarcity. It would therefore, be interesting to know more about Burrowing Owls on larger pastures in order to fully understand the true nature of the area/number relationship.

Given that larger pastures have more owls, it is perhaps not surprising that pastures that were occupied longer were larger. A smaller number of owls on a pasture is maybe likely to become extinct purely as a matter of chance. However, smaller pastures may also be subject to heavier levels of predation (Terborgh 1989) leading to the same result. Further work is needed on this point despite the preliminary results from the Regina Plain showing no such effects.

In summary, it would appear that pasture area may be playing an important role in the population ecology of the Burrowing Owl in Saskatchewan. However, more detailed analyses are required to further elucidate this and other relationships. In particular, it would be useful to also examine the effects of pasture edge, adjacent habitat land uses, isolation, and time since fragmentation and to conduct more work on owls on larger fragments of habitat. Given the role that predators seem to be playing in other studies of habitat fragmentation, it would also be useful to examine them more closely than what we have to date.

ACKNOWLEDGMENTS

Excellent field support for this study has been provided by Merv Hey, Tom Ethier, Paul Chytyk, Enid Cumming, Mark Todd, Geneen Russo, and Molly Toutloff. Financial and other support has come from the Canadian Wildlife Service, World Wildlife Fund, FMC Corporation, Wildlife Habitat Canada, Saskatchewan Natural History Society, and the Saskatchewan Museum of Natural History Associates. Access to Operation Burrowing Owl data files was provided by the Saskatchewan Natural History Society. To all of the above, I extend my deep appreciation.

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TOWARDS A CANADIAN CONSERVATION STRATEGY FOR RAPTORS

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The conservation of wildlife is important to most Canadians. Increasingly, Canadians are aware of the plight of many species of wildlife. In 1981, 80% of Canadians felt it was important to conserve abundant wildlife (Filion et al. 1985). This number rose to 83% by 1987 (Filion et al. 1989). These percentages are only slightly lower than those for Canadians who felt it was important to conserve endangered species (82% and 85% respectively, ibid.).

Reflecting these figures, the federal Green Plan incorporates wildlife in its conservation strategy (Government of Canada 1990). Songbirds in particular are singled out for attention. Past conservation activities of federal, provincial, and territorial wildlife agencies emphasized game and endangered species. Thus it is appropriate, if not overdue, that songbirds are afforded increased attention. However, in my view, adequate attention has not been given to another group of species—raptors. This paper expresses concerns about the current status of raptor conservation and proposes possible solutions to these concerns.

BACKGROUND

The Migratory Bird Convention Act (1917) excludes raptors. Raptor management and conservation is a provincial and territorial responsibility. The activities of the provinces and territories on raptors have focused almost exclusively within their borders.

Eleven species and subspecies of raptors are listed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as of April 1992. Two are endangered - Peregrine Falcon (*Falco peregrinus anatum*) and Spotted Owl (*Strix occidentalis*); two are threatened - Ferruginous Hawk (*Buteo regalis*) and Burrowing Owl (*Athene cunicularia*); and seven are vulnerable - Cooper's Hawk (*Accipiter cooperii*); Red-shouldered Hawk (*Buteo lineatus*); Peregrine Falcons (*F. p. tundrius* and *F. p. pealei*); Common Barn Owl (*Tyto alba*); Flammulated Owl (*Otus flammeolus*); and Great Gray Owl (*Strix nebulosa*). Three raptor species have formal recovery plans although as of February 1992 only one, the *Anatum* Peregrine Falcon recovery plan, has been approved by the wildlife directors (the other two, Burrowing Owl and Ferruginous Hawk, were approved in November 1992). The RENEW (Recovery of Nationally Endangered Wildlife) Committee's policy does not mandate recovery teams for vulnerable species. However, their goal is "to prevent other species from becoming at risk" (page i, RENEW 1988) or "no species be allowed to become threatened" (page 1, ibid).

Five of 16 species of owls and six of 19 species of diurnal raptors that breed in Canada are listed as endangered, threatened, or vulnerable (Table 1). Thus 26% of the species of raptors are listed by COSEWIC, a higher percentage than any other species group. Most of these raptors in jeopardy migrate south of Canada in winter (Table 2). Some species winter in

Table 1. Summary of the number of species of Canadian raptors that occur in United States and Latin America (Godfrey 1986) and are listed by COSEWIC as of 1992.

	Breed in Canada	Winter in Canada	Winter in U.S.A.	Winter in Lat. Am.	Winter in Mexico	COSEWIC[1]
Diurnal Raptors	19	11	17	18	6	E = 1 T = 1 V = 4
Owls	16	15	16	1	1	E = 1 T = 1 V = 3

[1] E = Endangered, T = Threatened, V = Vulnerable

Table 2. Status and distribution of raptors that occur in Canada.

Species	Status[1]	Breeding range in Canada[2]	Winter range of Canadian Owls[3]	1992 COSEWIC status[4]
Common Barn Owl (*Tyto alba*)	B	R-S	C, U	V
Flammulated Owl (*Otus flammeolus*)	B	R-S	C, U	V
Eastern Screech-owl (*O. asio*)	B	R-S	C, U	
Western Screech-owl (*O. kennicottii*)	B	R-S	C, U	
Great Horned Owl (*Bubo virginianus*)	B	W	C, U	
Snowy Owl (*Nyctea scandiaca*)	B	A	C, U	
Northern Hawk-Owl (*Surnia ulula*)	B	W	C, U	
Northern Pygmy-owl (*Glaucidium gnoma*)	B	R-S	C, U	
Burrowing Owl (*Athene cunicularia*)	B	R-S	U, M	T
Spotted Owl (*Strix occidentalis*)	B	R-S	C, U	E
Barred Owl (*S. varia*)	B	W	C, U	
Great Gray Owl (*S. nebulosa*)	B	W	C, U	V
Long-eared Owl (*Asio otus*)	B	W	C, U	
Short-eared Owl (*A. flammeus*)	B	W	C, U	
Boreal Owl (*Aegolius funereus*)	B	W	C, U	
Northern Saw-whet Owl (*A. acadicus*)	B	W	C, U	
Black Vulture (*Coragyps atratus*)	A	N	U, L	
Turkey Vulture (*Cathartes aura*)	B	R-S	U, L	
Osprey (*Pandion haliaetus*)	B	W	U, L	
American Swallow-tailed Kite (*Elanoides forficatus*)	A	N	U, L	
Mississippi Kite (*Ictinia mississippiensis*)	A	N	U, L	
Bald Eagle (*Haliaeetus leucocephalus*)	B	W	C, U, M	
Northern Harrier (*Circus cyaneus*)	B	W	C, U, L	
Sharp-shinned Hawk (*Accipiter striatus*)	B	W	C, U, L	
Cooper's Hawk (*A. cooperii*)	B	R-S	U, L	V
Northern Goshawk (*A. gentilis*)	B	W	C, U, M	
Red-shouldered Hawk (*Buteo lineatus*)	B	R-S	U, M	V
Broad-winged Hawk (*B. platypterus*)	B	B-S	L	
Swainson's Hawk (*B. swainsoni*)	B	R	L	

Red-tailed Hawk (*B. jamaicensis*)	B	W	U, L	
Ferruginous Hawk (*B. regalis*)	B	R-S	U, M	T
Rough-legged Hawk (*B. lagopus*)	B	A	C, U	
Golden Eagle (*Aquila chrysaetos*)	B	W	C, U, M	
Eurasian Kestrel (*Falco tinnunculus*)	A	N	-	
American Kestrel (*F. sparverius*)	B	W	C, U, L	
Merlin (*F. columbarius*)	B	W	C, U, L	
Peregrine Falcon (*F. peregrinus*)	B	W	C, U, L	E, V, V[5]
Gyrfalcon (*F. rusticolus*)	B	A	C, U	
Prairie Falcon (*F. mexicanus*)	B	R-S	C, U, M	

[1] Status: A = Accidental - not recorded annually in Canada; B = Breeds.

[2] Breeding Range: R = Restricted (S = southern, N = northern); B = Boreal forest; W = Widely distributed; A = Arctic; N = Non-breeder.

[3] Winter Range: C = in Canada; U = in United States; L = in Latin America; M = in Mexico.

[4] COSEWIC Status: E = Endangered; T = Threatened; V = Vulnerable; blank = not listed by COSEWIC.

[5] Refers to subspecies *anatum*, *tundrius*, and *pealei* respectively

Canada and the United States while others migrate as far south as Argentina and Chile. Many winter in tropical Central America. Little is known about their winter habitats or ecology. For some species such as the Burrowing Owl we do not know where the Canadian breeding population spends the winter (James and Ethier 1989). Eighteen of the 19 diurnal raptors and one of the owls are neotropical migrants. All 35 species winter in or migrate through the United States.

An international agreement, CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) lists all species of Canadian raptors. This convention restricts the movement of wildlife and wildlife parts between signatory countries, including Canada (see Dauphine 1987 for details). The convention does not address any other species' conservation concerns. CITES restricts the export of raptors and raptor parts from Canada.

Several relevant raptor management documents have been prepared in the United States. Olendorff et al. (1980) reviewed raptor management in the 1970s in the United States and categorized activities into captive breeding projects, egg manipulations for raptor management, introduction techniques for raptors, establishment of key raptor habitat reserves, and a proliferation of raptor habitat management projects. Olendorff et al. (1989) described objectives, goals, and actions to manage raptor habitat on lands of the United States Bureau of Land Management (BLM) in the western states and Alaska. For BLM lands, this report details the status of raptor habitat, effect of land use activities, and key raptor areas.

RAPTOR CONSERVATION ISSUES

Many conservation issues surround Canadian raptors. This section briefly outlines these issues in a preliminary fashion. A more complete review is part of the proposal presented in this paper.

Monitoring

The distribution, population size, and trends of most raptors are poorly or not known, especially in Canada. Bird monitoring techniques such as breeding bird surveys (Robbins et al. 1986, Buchanan 1988), and Christmas Bird Counts (Root 1988) monitor some diurnal raptors and few nocturnal owls. However, sample sizes are small for most species (e.g., 1 Cooper's Hawk and 1 Great Horned Owl [*Bubo virginianus*] per 33 Breeding Bird Survey routes) and few surveys are conducted in boreal and northern Canada. Raptor migration is monitored at many sites across the United States but at few sites in Canada. At these sites some useful long-term trends have been established, but many species are not covered.

Habitat

The general breeding habitat preferences of many raptors are known. Likewise we know the range of most species. However, we know relatively little about the specific habitat needs such as abundance of prey, breeding site, and foraging habitat. Productivity varies between habitat for all species. In some habitats, breeding birds produce a surplus of young (source habitat) while in other habitats the adults do not produce enough young to replace themselves (sink habitat) (Newton 1992). Source and sink habitats need to be defined for all raptors.

Environmental Assessment

The impact of land management practices on raptors is unknown in Canada. Environmental assessments use habitat-species relationships to predict the consequences of development on wildlife. Schmutz (1987) showed that intermediate agricultural activity increases the density of Swainson's Hawks (*Buteo swainsoni*) over native habitat and complete agriculture. Such examples are rare and more research needs to be done on the interaction between each development and the affected raptors.

Habitat Outside Canada

Seventeen species of raptors that occur in Canada are considered "neotropical migrants" by the United States Partners in Flight Program. These species breed in Canada and migrate to Central and South America for our winter. The migration and wintering habitats of many raptors are unknown or only poorly known. These habitats need to be identified and adequately protected in reserves, and managed for raptor survival. Likewise, little is known about mortality factors and toxicology issues in winter. Most, if not all Latin American countries have limited resources to study these migrant species.

Toxicology

Since raptors are at or near the top of the food chain, they accumulate persistent chemicals as well as being vulnerable to direct and secondary poisoning. The most famous example of bioaccumulation of a detrimental pesticide is the levels of DDT/DDE in Peregrine Falcons which caused thin egg shells and reproductive failure (Hickey 1969). The bioaccumulation of heavy metals and pesticides in raptors varies with their diet, geographic range, and habitat preferences. Direct poisoning occurs when the raptors are sprayed with a pesticide or ingest a toxic chemical. Carbofuran spraying of Burrowing Owls is an example (James and Fox 1987). Secondary poisoning occurs when raptors eat prey that are poisoned themselves. Fenthion, used to kill pigeons, has subsequently killed raptors (Lacombe et al., in press).

Mortality

Raptors are killed by many human activities such as: shooting; introduced disease, vehicle collisions, breeding disturbance; electrocution, and collisions with windows, buildings, and wires. The impact of these mortality factors needs to be assessed and where necessary, mitigated.

Falconry

Falconry is legal and is practiced in British Columbia, Alberta, Saskatchewan, Ontario, and Yukon. The impact of falconry is controversial especially in Ontario, but its documented impact on raptor populations or their prey appears minimal.

Education

Raptors hold a special fascination with the public. The public is interested in the raptors' shape and hunting skills. Because of this interest, raptors are particularly well suited as a focus for public education about wildlife conservation and broader environmental issues.

Raptors also occupy the top of some food chains. Landowners see many raptors soaring over their land or nesting on it. Consequently, raptors can be used as indicators of the quality of land management practices and as ambassadors of conservation of native habitat.

Research

Research on raptors is conducted primarily by a few university researchers in Canada. Recent federal-provincial forestry agreements initiated model forest research projects and some monitoring and research on raptors can be expected in most of these projects. Some government wildlife agencies monitor some raptor population but have few resources for research.

Research could help to provide answers to conservation problems. The conservation issues that would benefit from more research activity include: evaluation of survey techniques to monitor populations, determination of habitat use and diet, studies of the impacts of agricultural and forestry activities on raptors, and the risks posed by toxic chemicals. All of these issues need studying in Canada and Latin America.

Partnerships

Raptors and associated human activities are managed by provincial and territorial wildlife agencies. Management efforts would be more effective and efficient with improved communication among themselves or with researchers on issues such as raptor banding, falconry, raptor rehabilitation, and toxicology.

Likewise, there is little international communication and cooperation about raptors, even though breeding populations are contiguous with the United States and many migrate to Latin America. An international migratory bird agreement that included raptors in the western hemisphere would promote conservation and education.

Rehabilitation

Raptor rehabilitation is practised in most or all provinces and territories in Canada and is controlled by permits for the appropriate provincial and territorial jurisdiction. The effectiveness of these facilities needs evaluation nationally. Also communication between facilities needs to be increased to share information. National leadership to form a Canadian association would expedite the continued role and effectiveness of these facilities.

CONCLUSION

Since a high proportion of raptors appear to be at risk in Canada and many are neotropical migrants, there is a need for a concerted effort to manage these species both in Canada and in the rest of the Western Hemisphere. The many issues that surround raptors could be efficiently addressed by a national conservation strategy. Such a strategy could propose national and international ways to promote raptor conservation while reinforcing those issues that should remain with the current jurisdictions.

The strategy should be developed by a task force comprised of federal, provincial, territorial, university, industry, and non-profit agency representatives. They should be mandated by and report to a national body such as RENEW or the Federal-Provincial Wildlife Conference. The conservation strategy should identify solutions that are practiced under existing legal and administrative arrangements as well as proposing new tools to conserve these species.

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"WILD HUNTERS - PREDATORS IN PERIL" - A CONSERVATION STRATEGY FOR LARGE CARNIVORES IN CANADA

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INTRODUCTION

The presentation you will see today is what we provide to popular audiences across Canada. Based on World Wildlife Fund's (WWF) Conservation Strategy for Large Carnivores in Canada (Hummel 1990), and "Wild Hunters - Predators in Peril", a new WWF book (Hummel and Pettigrew 1991). Illustrated by Robert Bateman, we've detailed the historical and current situation facing Canada's six top predators, namely the Polar Bear (*Ursus maritimus*), Grizzly Bear (*Ursus arctos*), Black Bear (*Ursus americanus*), Wolf (*Canis lupus*), Cougar (*Felis concolor*), and the Wolverine (*Gulo gulo*). "Wild Hunters" doesn't stop at outlining the biology and threats to these top predators, but also details a "Blueprint for Survival" for each species.

It's ironic that these powerful carnivores at the top of the food chain have fared the worst in relation to humans. Addressing the often asked question, "why conserve these animals in the first place?," we show how each of these top predators plays an important role in natural systems. They regulate prey numbers that have evolved to exist in higher numbers. They are often "indicators" of ecosystem integrity because they require large areas of remote wilderness in which to live. If an area is big enough to include top predators, it likely accommodates the many other species in that ecosystem; and, top predators are an integral part of maintaining biological diversity. By conserving top predators, and the habitats of which they are a part, we'd be conserving biological diversity.

Another reason for conserving top predators is their value to people. Top predators played, and still play, important roles in aboriginal native cultures and economies. These animals are used by hunting communities of present day society. More recently, wildlife viewing is proving very important to local communities, as well. For example, Churchill, Manitoba is now billed as "the Polar Bear capital of the world," hosting tourists who come from far and wide to view these magnificent arctic bears.

Despite the dollar value of top predators, many people feel these species are worth saving for their own sake. Surely it's important to hang onto the different forms of life, whether or not they are useful to us.

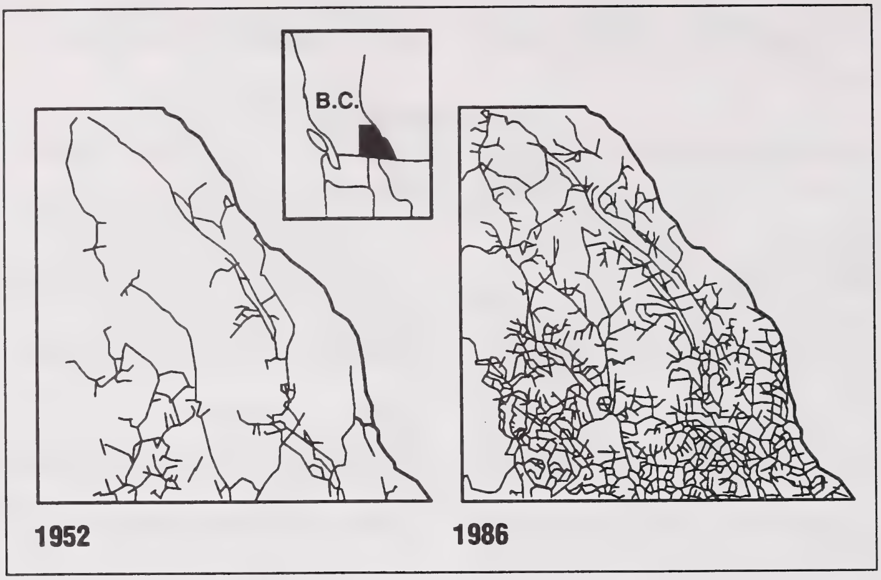
Finally, it's important to conserve top predators in Canada because there's a real urgency to the situation: they're taking their last stand, globally, in this country! Figure 1 clearly shows one of the reasons why: it compares the increase in access roads over the last 30 years in only one area of British Columbia. Increased access into wilderness backcountry is one of the greatest threats to all wildlife, causing disturbance of habitat, displacement of wildlife, and making hunting or poaching that much easier.

Top predators are now found right across the spectrum with respect to the classification of species in Canada. As seen in Figure 2, some of these top predators, or subpopulations of them, range from abundant, to rare or vulnerable, to threatened or endangered, through to those on the brink of extinction, such as the Eastern Cougar (*Felis concolor couguar*).

THE POLAR BEAR

The Polar Bear, an arctic marine mammal, is a very slow reproducing top predator. Polar Bears become sexually mature only after reaching four to six years of age, and usually give birth to one or two cubs which stay with the female for approximately 2½ years. This means that, on average, the female will only breed every third year and since cub survival rate varies, some female Polar Bears may not even "replace themselves" in the course of their lifetime. Female Polar Bears den from mid-October to mid-November, often returning to den sites where they themselves were born.

Ringed Seals (*Phoca hispida*) are the primary food of Polar Bears, although Bearded (*Erignathus barbatus*), Harp (*Phoca groenlandica*), and Hooded Seals (*Cystophora cristata*), Walruses (*Odobenus rosmarus*), Belugas (*Delphinapterus leucas*), and Narwhals



Source: B.C. Wildlife Branch, Cranbrook Regional Office.

Figure 1. Road development in the Kootenays.

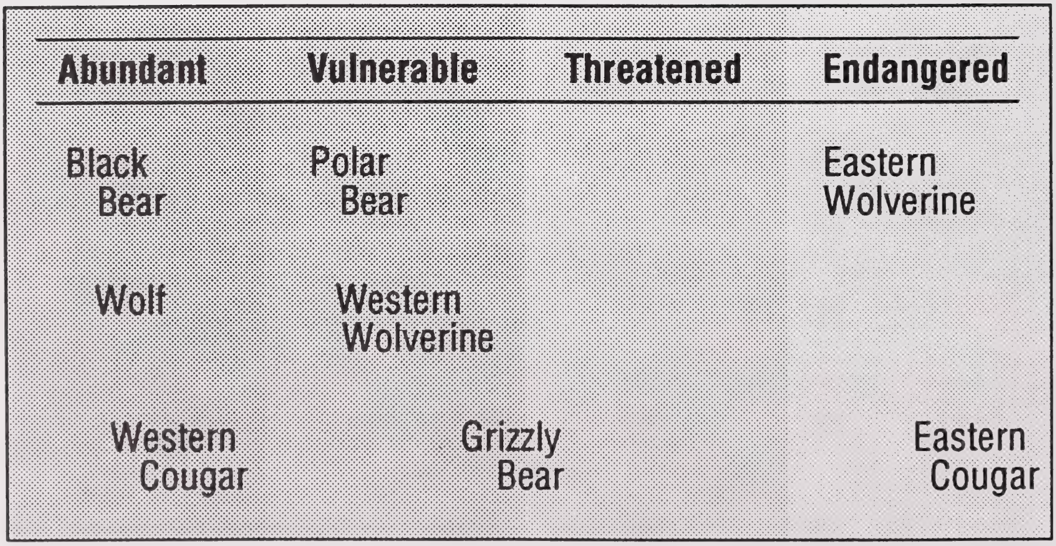


Figure 2. Predator status scale.

(*Monodon monoceros*) can also make up a portion of their diets. The abundance and distribution of Polar Bears in Canada is directly related to the abundance and distribution of seals. However, contamination from oil, PCBs, and toxic metals are increasing threats to Polar Bears and their prey in the Arctic.

When Polar Bears come into contact with people, they often become what are called "problem" bears. Although many garbage dumps have been cleaned up, it is what people do that makes problems out of wildlife.

There are more than 15 subpopulations of Polar Bears worldwide, 12 of which are in Canada. Scientists estimate the worldwide population to be between 25,000 to 40,000 animals. Canada is home to half of these.

Blueprint for Survival

International Cooperation

To ensure the future of Polar Bears, Canada must continue its participation in the International Agreement on the Conservation of Polar Bears and Their Habitat (appended in "Wild Hunters") and its role in the World Conservation Union (formerly International Union for the Conservation of Nature, [IUCN]) Polar Bear Specialist Group.

Canadian Measures

Canada must also continue coordinating both research and management measures, particularly as some bear subpopulations are "shared" by different jurisdictions and are, therefore, under differing pressures.

Aboriginal Hunting

Inuit residents still hunt the Polar Bear, which commands a high place in their culture and economy. It is very important that hunting quotas are worked out in cooperation with aboriginal peoples; about 700 Polar Bears are killed every year.

Protecting Critical Habitats

The protection of critical habitats, such as den sites and key feeding areas, must be ensured.

Reducing and Preventing Industrial Impacts and Toxic Chemicals and Greenhouse Gasses

It's crucial to reduce and prevent the industrial effects of development in the Arctic, oil pollution, tanker traffic, as well as toxic chemicals and greenhouse gases. What we do elsewhere can and does impact Polar Bears in the north.

Research Needs for Conservation

There are at least five areas of research that need to be further developed and funded. These include obtaining better data on the size and boundaries of subpopulations, through to better understanding Polar Bear reproduction.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Designation

Worldwide, the Polar Bear has been classified by the IUCN (now the World Conservation Union) as "Vulnerable," and is listed on Appendix II of Convention on International Trade in Endangered Species (CITES). In April 1991, Canada's Polar Bears were classified by the COSEWIC as "Vulnerable," not because Polar Bears are an endangered species, but because they are naturally found in low numbers over large areas, they have a slow reproductive rate, and they are vulnerable to negative environmental affects.

THE GRIZZLY BEAR

The Grizzly Bear, a member of the brown bear family, was once the most widespread bear species in the world.

The grizzly is the slowest reproducing top predator in Canada, females becoming sexually mature only after reaching five to eight years of age. They may then only reproduce at three to eight year intervals, having just one or two cubs.

Grizzlies require immense home ranges. Alpine habitat is very important to them, a habitat type that is under increasing pressure in some areas of Canada for agriculture, which results in displacing grizzlies. Resource extraction and development in wilderness can destroy habitat, and provide increased human access into backcountry.

Another direct pressure on Grizzly Bears is hunting, both legal and illegal. In most areas of Canada, it is still legal to hunt grizzlies in both the fall and the spring. Some studies have shown that in the 12 zones where Grizzly Bears still exist in Canada, they are legally over-hunted in five. This doesn't include illegal hunting for which the head and paws are removed for trophies and jewellery.

As with Polar Bears, grizzlies are often attracted to human habitation where garbage is carelessly managed. Often, a problem bear becomes a dead bear. Although a grizzly takes the blame for frightening or attacking a human, it is usually our own lack of knowledge about bear behaviour that results in such tragedy.

Blueprint for Survival

Conservation Status in the United States and Canada

The Grizzly Bear has been eliminated from 99% of its range in the lower 48 United States, leaving only 700 to 900 bears more or less confined to six national parks there. Even here, in Canada, grizzlies occupy just over half their historic range, with population estimates of about 25,000 Grizzly Bears across their remaining habitats.

Listed as "Threatened" in the United States, the Grizzly Bear is protected under the Endangered Species Act there. COSEWIC identified 14 Grizzly Bear zones in Canada, and concluded that grizzlies are "Vulnerable" in seven, "Threatened" in one, and "Extirpated" in the two zones on the prairies where the grizzly is actually extinct. In 1991, Canada's entire Grizzly Bear population was formally classified as "Vulnerable." WWF believes the existing status decisions regarding Grizzly Bears by COSEWIC should be carefully monitored annually, so that they can be updated as necessary for the conservation of Grizzly Bear populations at risk.

Direct Killing by Humans

So far, no subpopulation of Grizzly Bears in Canada has been formally classified as "Threatened" or "Endangered." However, the grizzly is still regarded as a game species here and, as mentioned earlier, is the object of both spring and fall hunting seasons in some areas. Because of their slow reproductive rate, the killing of grizzlies, especially females, can have serious consequences for the species.

Habitat Loss

To ensure survival of the species and subpopulations, Grizzly Bear habitat must be protected, particularly den sites, critical feeding areas, and travel routes.

Access

Increased human access has had disastrous effects on Grizzly Bears, making them more vulnerable to hunting and poaching. Many access roads could be closed off.

Sanctuaries

It is important to establish conservation areas, to protect their cores, and to modify human activities around these areas.

Bear Attacks and Human Safety

Grizzly Bear behaviour is not well understood by many people, and grizzlies are often feared, which has led to their persecution. There are some insightful books on how to avoid people/bear confrontations, and it's important that people learn how to avoid and deal with bear attacks.

Government Cooperation

The four Canadian jurisdictions which still have Grizzly Bear populations, Alberta, British Columbia, the Yukon and Northwest Territories, must continue to coordinate their efforts in order to conserve this top predator.

Research

There are several important research needs in relation to Grizzly Bears. Developing better census techniques, determining the impact of hunting levels on some subpopulations, and better understanding bear behaviour are but a few.

THE BLACK BEAR

Indigenous only to North America, the American Black Bear is a creature of forested habitats. These forests provide den sites, food, protection, and escape from harassment. Therefore, the Black Bear's future is closely tied to whether or not some forests are left standing.

Black Bears are relatively slow-reproducing top predators, but generally reproduce more quickly than Polar Bears or grizzlies. The age at which females become sexually mature usually depends upon the quality of their habitat. For example, in east-central Ontario, where food supply is inconsistent, females don't have a first litter until they are between five to seven years old. On average, however, sexual maturity occurs at three to four years of age, with litters of two cubs, every two or three years.

There are a number of subspecies of Black Bears, but they're not always black. For example, the rare, white Black Bear—known as the Kermode (*Ursus americanus kermodei*) or "Spirit Bear"—is found only on Princess Royal Island, off British Columbia's north coast.

Currently considered Canada's most abundant top predator, with estimates of almost 300,000 across less than half their former range, Black Bears face a great deal of pressure from habitat loss, hunting, and now, a frightening new trend: the growing trade in Black Bear gall bladders and paws (Table 1). A bear's gall bladder is removed, dried, ground up into a powder and used in traditional eastern medicines. In 1991, the Black Bear was listed on Appendix III of CITES, which means that the legal international parts trade is now, at least, being monitored.

Blueprint for Survival

Conserving Black Bear Subpopulations

To ensure a future for Black Bears in Canada, protected areas must be established, which include the many natural regions, habitat types, and eco-regions that Black Bear subpopulations require.

Hunting Regulations

It appears that approximately 8% of Canada's Black Bears are legally hunted every year, which means that over 22,000 bears are killed. This is extremely high for such a slow-reproducing species, especially as other pressures on Black Bears increase. Hunting must be regulated more carefully, and spring hunting seasons should be eliminated.

Controlling the International Trade in Bear Parts

The listing of Black Bears on CITES Appendix III is a step in the right direction, but only with regard to monitoring, not controlling, the legal international trade. Therefore, Canada urgently needs clear legislation and strong enforcement at federal, provincial, and territorial levels to control or ban trade in bear parts throughout this country. The new federal Wild Animal and Plant Protection Act is also a step in the right direction.

THE WOLF

Wolves were once the most widely distributed mammal in the world. Now, in North America, wolves are found only in the more remote, timbered and tundra habitats. Even where they are numerous, they're rarely seen. Wolves require large expanses of wilderness habitats in which to live.

They are the fastest reproducing of these six top predators. However, wolves have a very sophisticated social structure dominated by an alpha female and male, which are usually the only pair that breed in a wild pack. Wolf packs are an extended family unit, mostly comprised of young from previous generations. Wolves are a "controversial" predator because they rely upon species for food which are also valued by humans—species such as Moose (*Alces alces*), deer, Elk (*Cervus elaphus*), and caribou. Because of agriculture, urbanization, and all-out predator killing programs, wolves have been eliminated from 95% of their range in the lower 48 United States. Canada is still home to approximately 50,000 to 60,000 wolves, occupying about 85% of their former range here (Figure 3).

Blueprint for Survival

Ethical Questions

Wolves are persecuted whenever they come into competition with people, much of it based on ignorance and fear. Human society must, therefore, confront some serious ethical questions as to whether or

Table 1. Bear parts trade activity and trends in Canada (Sheeline 1990).

Province	Trade activity in province (legal or not)	Legal to sell parts?	Trends in trade within the province	Parts goint to out-of-province destinations?	Local use of parts within province
Alberta	infrequent	yes	stable-growing	yes	yes
British Columbia	active	yes	growing	yes	yes
Manitoba	active	yes	growing	yes	yes
New Brunswick	active	no	unknown	yes	no
Northwest Territories	active	yes	none	yes	yes
Nova Scotia	infrequent	yes	stable	yes	yes
Ontario	active	no	growing	yes	yes
Quebec	infrequent	yes	growing	yes	yes
Yukon	active	no	growing	yes	yes

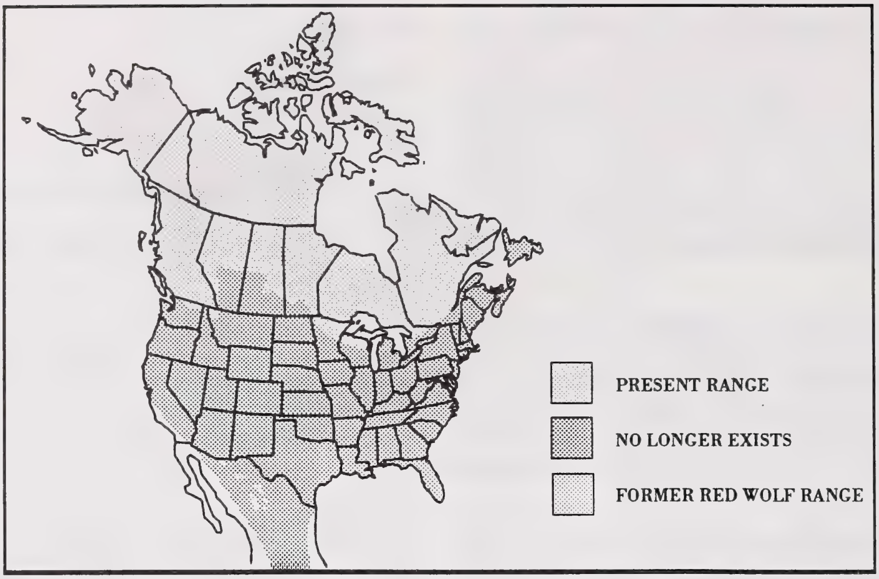


Figure 3. Historic and present range of wolves in North America.

not we are prepared to coexist with wolves in the wilderness.

Controlling Wolf Control

Wolf control programs, most often used to decrease the number of wolves in order to increase the numbers of deer, Elk, caribou, etc. for human use, must be subject to public scrutiny and process, if they are used at all.

Protected Areas

Presently, the combined area of current national and provincial parks, wilderness areas, and wildlife reserves protects only about 2.7% of Canada's estimated Wolf population, or about 1,600 Wolves. As Wolves are heavily trapped and hunted around the periphery of national parks, and hunted within most other parks, the adequacy of areas in Canada that protect Wolves must be reexamined.

Hunting Policy

In many Canadian jurisdictions, Wolves are hunted year-round with no bag limits. Hunting policies with respect to Wolves must be tightened up.

Recolonization and Wolf Recovery

In some cases, Wolves are naturally recolonizing some of their former range—for example, in Montana where Wolves have travelled south from British Columbia/Alberta. These efforts should be supported—rather than discouraged by increased trapping and hunting pressures in the Wolves' new range and place of origin.

Wolf Appreciation

Few people have heard the howl of the Wolf in the wild, but once heard, it's unforgettable. Wolf howling expeditions in Ontario's Algonquin Park, for example, are leading to a greater appreciation of this top predator. With care, this type of "wildlife viewing" could be duplicated in other jurisdictions, providing an economic boost to local communities.

Canadian Strategy

The IUCN Wolf Manifesto (appended in "Wild Hunters") urges the protection of different subspecies of Wolves and their habitats. A Canadian conservation strategy should ensure the future of all 17 subspecies of Wolves in Canada.

International Cooperation

Canada's continued cooperation with international bodies such as the IUCN Wolf Specialist group is important to the Wolf's future here at home and elsewhere in the world.

THE COUGAR

The Cougar, Canada's rarely seen wild cat, favours remote wilderness environments—not just mountain habitats, but foothill country as well. Unlike other top predators, female Cougars can breed during any season, giving birth to two to four kittens which will stay with their mother for up to two years. Of course, not all kittens survive to become adults. Because of this ability to breed in any season, it is always possible that kittens may be present if a female Cougar is observed or shot.

The Cougar's instinct, when it is in danger, is to climb a tree, which often results in its death if a dog and a hunter are involved. Hunters use dogs to track and "tree" a Cougar; the dog(s) keep the Cougar "at bay" until the hunter arrives to shoot it from the tree.

Cougar have been wiped out from nearly all their range in the eastern United States. Canada's Eastern Cougar is listed as an endangered species, and thought by some experts to be extinct. The only remaining viable Cougar populations are found in Alberta (with approximately 600 Cougar) and British Columbia (home to an estimated Cougar population of between 2,280 to 3,800). These two provinces share national responsibility for the fate of this wild cat in Canada.

Blueprint for Survival

International Guidance and Canadian Strategy

To ensure the future of Canada's Cougar, the IUCN Cat Specialist Group's international conservation document entitled, "Saving The Wild Cats" (appended in "Wild Hunters") should be used as a guide for Canadian wildlife managers to develop a Canadian strategy. This would ensure that healthy Cougar populations prevail in the west, while maintaining what may be a remnant population in the east.

Habitat Protection

Degradation of Cougar habitat is the greatest threat to Canada's Cougar populations. Protecting Cougar habitat, and the habitat of their prey, is extremely important for the future of this species.

Hunting Regulations

Although hunting regulations are currently being amended in both Alberta and British Columbia, it appears that Cougar have been overhunted in some management units. "Will-call" hunts should be banned. This is where an individual, on behalf of a hunter, tracks and trees a Cougar, then contacts the hunter who purchases a Cougar licence, and eventually arrives to shoot it. "Off-season" dog training should be controlled, and possibly banned in some areas of Cougar range.

Control Programs

Historically, extensive Cougar control programs were used in the lower 48 United States and in some areas of Canada. These control programs, and Cougar bounties, should never be reinstated.

Public Information and Research

Expanded field research and more accessible public information on Canada's Cougar would lead to a greater understanding of this elusive wild cat, and go a long way toward ensuring its future.

THE WOLVERINE

The Wolverine, a large member of the weasel family and the most mysterious top predator of them all, is a true wilderness inhabitant, found only in the most remote parts of our country. Wolverine are seldom seen by people, other than trappers and biologists who are studying them. Wolverine are legendary for breaking into trappers' cabins, and then spraying them with their strong smelling musk.

Scavengers by nature, Wolverine feed on carrion. Therefore, when other animals such as deer or Moose die from exposure or starvation during a harsh winter, the Wolverine have more to eat. Their reproduction depends largely on food conditions, so the female will reabsorb the embryo if food is scarce. If food conditions are good, females may give birth to two or three kits, but even then, not every year.

A direct pressure on Wolverine in Canada is trapping, but trapping records do not suggest that this is causing a decline. So little is yet known about Wolverine biology, however, that it may not be safe to even say that.

Eliminated from the southeastern portion of their historic range, Canada's Eastern Wolverine (*Gulo gulo luscus*) population (east of Hudson Bay) was classified in 1989 as "Endangered." Elsewhere, population estimates for Wolverine are difficult to determine, but they are thought at best to be a rare species spread out over large areas, and thus have been officially classified as "Vulnerable."

Blueprint for Survival

Canadian Population Goals

Since three Canadian jurisdictions are home to 75% of Canada's Wolverine, British Columbia, Yukon and the Northwest Territories, they share the greatest opportunity and responsibility to maintain still-viable populations of this vulnerable top predator. Other jurisdictions, particularly Québec, have the responsibility of hanging onto an endangered species—the Eastern Wolverine.

Trapping

The Wolverine is legally classified as a "furbearer," and government agencies regulate hunting and trapping accordingly. However, trapping must be strictly controlled, cooperatively or by regulation, particularly in the eastern part of Wolverine range.

International Trade

If more than 50% of Wolverine trapped enter international trade markets, the Wolverine should be placed on CITES.

Habitat Protection

It is very important to protect Wolverine habitat. Such an elusive, rare species is often overlooked when resource activities are being planned in wilderness areas.

Reintroduction

It is encouraging that Wolverine have shown an ability to naturally re-occupy former range (for example, in Montana). This should be further supported. Wolverine reintroduction programs are worth trying in areas where Wolverine were once found, where habitat is still sufficiently remote, and where their prey-base still exists. These areas must be protected if reintroduction is to be successful.

Research Needs

Wolverine continue to be the least known of Canada's large carnivores. Very few field studies were conducted on Wolverine, up until the last decade or so when WWF funded the first such studies in Canada. Research needs and public information on Wolverine are becoming urgent, as human activities alter what could be their last remaining wilderness landscapes.

A CONSERVATION STRATEGY

Although each of these six top predators is significantly different, some conservation steps can be taken which would benefit all of them. To accomplish this, "Wild Hunters" outlines seven strategic steps, based on WWF's Conservation Strategy for Large Carnivores.

Underlying these seven steps is a two-pronged approach. The first is a "preservation" approach: preserving natural habitats through the establishment of large protected areas with no industrial development. The second is an "integrated resource management" approach: modifying human activities on those lands and waters that are going to be developed and used by people, to ensure the long-term conservation of wildlife. The general goal of WWF's Conservation Strategy for Large Carnivores is: "To conserve viable, wild populations of large carnivores in Canada."

To accomplish this goal, the seven strategic steps are:

1. Determine population conservation goals. For each top predator, minimum viable population estimates (a still-evolving field of population ecology) have yet to be clearly determined. Preliminary estimates are offered in our book, "Wild Hunters." This information will be crucial to the long-term viability of Canada's large carnivores.

2. Establish Carnivore Conservation Areas (CCAs). CCAs are defined as "areas of sufficient size and managed in such a way to ensure long-term survival for free-ranging, minimum viable populations of large carnivores." CCAs are not places where large carnivores are conserved while they are wiped out everywhere else. Many CCAs can be centred or superimposed on already-existing protected areas.

A re-examination of Canada's existing protected areas network is required. Again, five preliminary areas are suggested for western Canada only, in "Wild Hunters." Are Canada's national and provincial parks large enough and being managed in such a way so as to ensure the long-term future of top predators? Are there other wild places where there's a possibility of establishing new reserves for Grizzly Bears, Cougar, and Wolverine?

3. Control killing by humans. Over 32,000 bears, Wolves, Cougars, and Wolverines are legally killed every year in this country, enough to occupy 37 (American) football fields if their pelts were laid-out side-by-side. And these figures do not include illegal kills. Clearly, legal hunting must be carefully regulated, and poaching reduced, or eliminated where possible.

4. Manage impacts on habitat. Each of these top predators is subjected to manipulation of its natural habitat, which can have a direct impact on its numbers. Each are also subjected to indirect impacts on habitat from industrial and agricultural activities, forestry operations, livestock grazing, garbage dumps, roads, etc., which affect distribution of prey species. All these, and other aspects must be understood, appreciated, and sensitively incorporated into the day-to-day operations of humans and their business when venturing into wilderness areas harbouring top predators and their prey.

5. Broaden public education. Reliable information should be demanded by and made available to people regarding the behaviour and ecology of top predators, especially given the misinformation surrounding these species. Only now are they becoming appreciated for their rightful role in ecological systems, and as symbols of wilderness.

6. Strengthen conservation research. More long-term research, including information on multi-predator/multi-prey systems, is crucial in order to avoid jumping to conclusions about predator or prey population trends based on a "snapshot" in time.

7. Improve cooperation. The importance of getting our governments to work together on the conservation of top predators cannot be over-emphasized. Efforts between the provinces, territories, and the federal government, as well as the private sector and academia, need to add up to enough to save these species on a national basis.

WHAT CAN YOU DO?

1. Speak up. "Wild Hunters" urges people to speak up, to be in touch with decision makers. Canadians have become very cynical about our political system, but if we don't have high expectations of it, we're likely to get exactly what we expect.

2. Join up. "Wild hunters" provides an extensive list of non-government organizations and government contacts to get people started.

3. Sign up. We urge people to sign the Canadian Wilderness Charter, part of WWF's "Endangered Spaces" Campaign, which calls for the establishment of protected areas representing each of the 350 natural regions of Canada by the year 2000. This would go a long way toward conserving top predators.

4. Read the regulations. We encourage people to become familiar with the hunting regulations for their area, by explaining how to obtain and read the them, through to what to look for in the way of hunting seasons and bag limits.

5. Learn more. We believe "Wild Hunters" will serve as a starting point to learn more. As well as outlining the historical and current biological information, we have incorporated quotes and anecdotes from forty scientists and other experts in the field, along with a full index and extensive bibliography.

6. Live what you believe. If everyone were more personally committed to recycling and reducing the resources consumed, believe it or not, it would be a big help to species as far away as the Polar Bear, Grizzly Bear, Black Bear, Wolf, Cougar, and the Wolverine.

Canada is a country where these top predators are taking their last stand. Therefore, it's very important to ensure that these species continue in viable populations into the future. After all, what would the earth be without them?

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MISFIT INSTITUTIONS, RATIONAL DECISIONS, ENDANGERED SPECIES

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To the fringes of the taiga, agricultural imperatives have come to dominate the rural prairie landscape. Once large-scale agricultural settlement commenced, in the mid-1870s, political and economic urgencies dictated the expansion of settlement at the maximum attainable rate. There was to be no methodical diffusion of agriculture, selective and adaptive, but, in large measure, a headlong rush by the overconfident leading and/or, pushing the ignorant.

Land was, after all, and since the emergence of feudalism in the lands of origin of the immigrant tide had been, identified with status, rights to it the prerogative of the aristocracy and the gentry. To homesteaders of peasant and proletarian background, ownership of land conveyed the promise of personal wealth and an upward surge in status absolutely unattainable in their countries of origin.

With the benefit of hindsight, the ecological consequences are readily discerned and easily determined to have been predictable. Even a cursory assessment reveals the dominant causes:

1. The urban proletarian elements which constituted a large proportion of the settlement tide were responding as much or more to dismal conditions in their industrializing homelands as to the prospects of land ownership and the vision of personal independence it conveyed. In the face of very limited alternative opportunities in a pioneer economy, commitment to an agrarian lifestyle was, for the majority, once arrived, not really a matter of choice, despite their lack of skills appropriate to decision-making in a totally unfamiliar physical and economic environment.

2. The settlers of peasant origin had behind them, in many cases, only one, and at most a few generations since their release from serfdom. The majority, in terms of their life-circumstances, had never progressed beyond the hard edge of privation. In their homelands, what survived of the natural landscape and its ecological legacy remained the private preserve of the gentry, interdicted to the peasant. The peasantry discerned no benefit to themselves from the wild creatures which inhabited such preserves, which to them appeared as a source of predation upon their crops and livestock. It need not surprise us that, in their new homeland, perceived or suspected predators, and their habitat, were eliminated as a matter of course, and by any means at hand. Parenthetically, it appears never, at an operational level, to have occurred to anyone that elimination of foxes, Coyotes (*Canis latrans*), hawks, owls, and other common predators, while sparing a few calves, lambs, and chickens, would unleash population explosions amongst their natural prey, with much greater economic consequences.

3. The majority of settlers of middle-class landowning background in Europe, eastern Canada, or the American mid-west were relative latecomers to the prairie pioneering scene, and brought with them a well-defined commitment to cash-crop commercial farming. Although, like that of their neighbours of proletarian and peasant background, their prior experience in milder, moister regions may have been minimally attuned to the rigorous prairie environment, they nevertheless came with capital and hence the capacity to project the machine age into the process of rapidly extracting the potential wealth accumulated in the soil through half-a-dozen post-glacial millennia or more. With the advent of mechanized agriculture, the drastic simplification of prairie ecology was assured and, very quickly, fact.

If certain feudal concepts of status associated with land were transplanted to the prairies, so were concepts in respect to the sourcing of public revenues. In pre-industrial time, land was the primary generator of wealth, the rights to it vested solely in the Crown, which handed off limited proprietary privileges to the aristocracy. The Crown informed its fiefholders of its revenue requirements; the aristocracy extracted them from the peasants bound to them. Real estate, together with taxes on goods, would persist as the primary source of public revenues. Taxes on newly-augmented wealth, that is on corporate and private net income, did not enter the revenue scene until the second decade of this century. When they did, however, as a progressive tax on the augmentation of net wealth, they were superimposed upon and did not supplant the regressive taxes on real estate. Relative to the rural ecological reservoir that is at root of our concerns, this expresses itself as annually recurring impositions on privately-owned land to defray the cost of societal obligations and commitments most of which represent no reciprocal advantage or benefit, direct or indirect, to the land which must generate them or be forfeit to the Crown. When, in the late 1930s, in the wake of the great depression, government acted to in future protect individuals' basis of livelihood from precipitate foreclosure, it carefully exempted itself. In respect to levies in support of education, however, municipal governments are, to use the feudal analogy, the aristocratic fiefholders, and the school divisions the monarch. The school divisions have merely to communicate their revenue requirements to the municipalities, which are legally bound to extract them from the real estate tax base. This item alone characteristically constitutes 50% or more of the taxes assessed, and cannot be dismissed as a factor influencing the wealth-extracting procedures applied to the land, especially in light of the pervasive threat of forfeiture for failure to comply.

Near larger centres across the prairies, hamlets within the commuter radius have, in the course of recent decades, greatly expanded to become primarily dormitory communities. Their commercial base, however, has hardly grown, since shopping habits continue to focus on the larger centres. Within the commuter radius of Winnipeg, as a case in point, a number of such hamlets have grown to a size that would permit them to incorporate. None has. As integral elements of the rural municipalities, a significant portion of the infrastructural costs engendered by their expansion as dormitory communities can be laid off onto the agricultural land which reaps no benefit but continues to represent the bulk of the assessed, taxable real estate. At the same time, such hamlets preferentially devour the best of the local ecological reservoir as preferred residential building and public recreational sites.

The assessment process recognizes several categories, based on the land's perceived ability, on a monetized basis, to produce wealth. So called wasteland, deemed incapable of producing such wealth, is assigned to the lowest monetized value category and hence is taxed at the lowest per-acre rate. Municipalities, in compiling the assessment notice, do not differentiate. They total all categories within a parcel of land to arrive at the assessed value, then multiply this by the mill rate to arrive at the current demand for taxes. The landowner is probably aware that, in varying terrain, the assessor has assigned various acreages to their different appropriate categories. Because his tax bill does not reveal these details, the landowner intuitively tends to average his tax burden over the entire acreage. This exaggerates the perceived imposition on the wasteland category which represents the bulk of whatever ecological reservoir survives in the vicinity. In any event the landowner is acutely aware that the natural produce of his wasteland upon which society-at-large has at all bothered to place a value is and remains the sole property of the Crown, which also reserves to itself the right, via licenses, to sell rights to that produce. Rational thinkers will, one would expect, have little difficulty in coupling the foregoing with the phenomenon of shrinking habitats and progressive local and regional endangerment and extinction of species.

Should the landowner elect to "improve" wasteland acreage whose appropriate "highest and best use" (to use the assessor's terminology, but not his criteria) would be to remain as it is, custodian of the ecological reservoir, he comes into imminent, if indirect benefits. Once it is mutilated beyond any capacity to fulfill its erstwhile ecological function, the Canadian Wheat Board, unencumbered by any concerns as to whether or not it can produce a cultivated crop, will unhesitatingly register such acreage as "improved," entitled to quota allocation and henceforth rendering economic benefits to the owner, if not in produce, certainly in terms of the rate of delivery and the quantity marketable from his productive acreage. Direct benefits may, moreover, be anticipated whenever the government, in economically depressed times, lends an improved acreage-based helping hand, such as the $5 per acre Farm Support and Adjustment Measures payment on "Canadian Wheat Board acreage" in January of 1992. Summerfallow, an acknowledged destructive, decertifying feature of our agriculture, will receive the "support" "after April 1, 1992." "Wasteland," the ecological reservoir, receives nothing.

Provincial crop insurance programs, by their terms of reference, promote the maximization of eligible acreage. So does the recently introduced federal initiative, Gross Revenue Insurance Plan. Of the federal and provincial programs directly impinging on agriculture, only Net Income Stabilization Act is relatively acreage-neutral. And yet, since the benefit formula is based on gross revenues, it too subtly encourages the appropriation especially of marginal lands, which have become the core of the remaining ecological reservoir, to the monetized production base.

The bulk of the immigrant tide that engulfed the prairies in the latter decades of the 19th Century and the early decades of the 20th had its origins in regions of moderate climate and abundant moisture, where mouldboard plowing dominated the tillage regime. Most crops were fall-planted. Mild winters and/or abundant snow cover promoted survival. Even the hardiest seedstocks imported to the prairies were, however, unable to survive the much harsher winters in the context of modest snowfalls, high prevailing wind velocities and the "obligatory" plow tillage which left nothing to break the wind and hold the insulating snow essential to plant survival. Spring seeding quickly became the inflexible rule in all but the chinook belt. So firmly was the futility of fall planting elsewhere on the prairies quickly ingrained that when rust resistance came to be included in the systematic search for improved varieties, the effort was entirely focused on spring-seeded crops. The chinook belt was not plagued by grain rust, and so fall-seeded crops were not brought into the program. Now, it is a myth that fall-seeded crops cannot reliably survive a prairie winter. Seeded into undisturbed snow-retaining stubble, existing varieties are quite hardy enough to survive throughout most of the so-called spring wheat belt. But, the existing varieties lack the essential rust resistance. Given the availability of even one variety of rust-resistant fall-seeded wheat, it can be confidently predicted that rationally applied economic and time-allocation considerations would quickly promote its adoption over a substantial proportion of the spring wheat belt. Such acreage would, quite incidentally but also quite inevitably, establish a blanket of habitat undisturbed until harvest, well past the subsequent nesting season. The question is, are we ready to accept and pursue "redemptive" results predictably, if incidentally, achieved as a side-benefit of "profane" exploits?

Recognition of several individual but mutually-reinforcing components of the ecological degradation/species endangerment syndrome induced by immigrant cultures alien to the nuances of our interior-continental environment is one thing. Devising solutions is quite another. One thing appears certain: In the main, an adequate level of success will hinge upon adjustments in background institutions to which the majority of proprietors of the ecological reservoir of the prairies—farmers and landowners—are constrained to make economically rational responses. Such adjustments must generate mutually supportive signals to decision-makers, culminating in retention, redress and retrieval with respect to the ecological reservoir, at little or no ancillary cost and hence immune to the pernicious implications of discount rate driven economics. With respect to the public as to the private sector, segmented jurisdictions and mandates contribute to the non-realization of environmental benefits and degradation of the ecological reservoir. Ownership of much of Canada's terrestrial and marine ecological resource-space continues to be vested in the Crown, which may grant usufruct rights under various forms of license or permit. As a case in point, rights to the extraction of timber are granted to producers of lumber, pulp, and paper. Clear-cutting is the dominant mode of exploitation. Reforestation, if undertaken, is single-species monocultural, coniferous.

One situation in which a major opportunity may be lost through adherence to "standard practice" is currently developing in the central and northern Interlake regions of Manitoba. Wood Bison (*Bison bison athabascae*) were introduced there in 1984, as a venture to augment the resource-base of the native population with a species which could colonize a hitherto vacant ecological niche. The bison have thrived, to the point that a release—so far successful—to the wild was achieved in 1991. Experience gained during preceding years has demonstrated that initial seeding of cutover areas to a grass-legume mixture greatly favours the bison. To retain the micro-climatic advantages of wind-shadow, individual cutover areas should be restricted to 1.5 to 2 km^2, preferably about twice as long as wide, with the long axis roughly at right angles to the dominant wind direction. With the appropriate adjustments to prevailing forestry practice, several thousand free-ranging bison at least could be accommodated in the central and northern Interlake, within the context of an improved environment for pre-existing wildlife populations in the same region.

Subsistence and commercial hunting, trapping, and fishing have been a persistent fixture sharing the woodland resource and watershed base with forestry, but they have hitherto had to accept forestry's pre-eminence. Perhaps society should re-examine and fine tune that situation. A multi-tiered approach dedicated to the maximization of the sum of opportunities appropriate to all interests, not least of these the sustaining of the woodland ecological reservoir of diversity, appears timely.

As to the prairie sector, in which private ownership dominates, it will be necessary to imbue the various response-provoking factors with policies that emit signals which in sum elicit an ecologically positive response. In attempting to formulate recommendations appropriate to that objective, it is wise to remember that initiatives that can be implemented entirely within the sphere of competence of a single level of government are less likely to falter than those requiring negotiation and reciprocal commitments up and down the municipal/provincial/federal escalator of competence and authority. Some concrete suggestions, not necessarily altogether consonant with the foregoing advice, are:

1. In respect to "unimproved" land, modify the Canadian Wheat Board regulations in such a way as to provide for quota entitlement, at least up to 25 or 30% of any individual farm's gross acreage. Equivalently, provide for retention of quota entitlement in respect to acreage retired from cultivation and committed to ecological reserve status.

2. Institute a zero-value assessment on wasteland within the municipal taxation system. Pro-rate the foregone revenues, on a municipality wide basis, onto agriculturally productive acreage or, preferably, achieve an offset through an increase in the number of points of the provincial income tax surcharge currently assigned to municipal revenues, thereby also acknowledging the stake that society-at-large has in an ecologically sound environment. Apply the revenue offset principle—perhaps at the 50% level—also to grazing and forage-producing acreage committed to non-disturbance until such time—likely in early to mid-July—as ground-nesting birds have brought off their first broods. A beginning needs to be made somewhere, to untax nature.

3. Institute detailed, explicit, categorized tax billings in respect to privately owned rural land, to counter the tendency of landowners to "homogenize" the levy into the average for an entire holding.

4. Mobilize the resources of Agriculture Canada in a high priority program to develop an acceptable strain of rust resistant winter wheat. It is not unrealistic, in the presence of this innovation, to visualize an annually recurring carpet of secure breeding season habitat across the spring wheat belt, greater in area than all the existing formal habitat enhancing and preserving programs combined.

5. Create a legislated framework within which landowners could, under caveat, commit any portion of their acreage to ecological reserve status without otherwise compromising the integrity of their title, but resulting in the removal of the acreage under the caveat from the municipal taxation base, and thereby further untax nature.

6. As a token of appreciation to landowners who informally maintain ecological reserves which favour populations of species in respect to which the Crown normally sells hunting licenses to all applicants, issue, on request, a complimentary, non-transferable personalized license. In respect to species subject to a limited issue of licenses, institute a parallel draw for complimentary licenses in respect to qualifying, habitat sustaining applicants.

7. Realistically, from political and economic perspectives, agricultural subsidies are likely to be a persistent feature of the rural prairie scene well into the future. It is difficult to devise support systems that are not acreage-sensitive. Free Trade and General Agreement on Trades and Tariffs (GATT) provisions are threatening conventional existing systems of subsidy delivery. To the extent that Free Trade and GATT interpose themselves between the Treasury and the farmer/landowner, ecological reserves and habitat enhancement fairly shout for attention as an elegant dodge. One thing is certain, the greater the extent to which individual rationally-made, ecologically uninfluenced choices can be construed to be incidentally congruent with ecological objectives, the greater our prosperity, individual and collective, will be. It may be as simple, and surely as dauntingly complicated, as that.

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AN EVALUATION OF THE PERFORMANCE OF ECONOMIC INCENTIVES TARGETED AT ENHANCING WILDLIFE HABITAT IN WESTERN MANITOBA

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The increased intensity of agricultural production in the past 50 years has had a large impact on the Canadian prairie environment. Approximately 40 percent of the natural wetland, 80 percent of the native prairie, and 75 percent of the aspen parkland habitats on the Canadian prairies have been destroyed. Agriculture is the primary force in this native habitat destruction (World Wildlife Fund 1988).

Market signals guide agricultural producers toward economically sound decisions. In the case of environmental services, which include the range of economic and social benefits provided by a healthy environment, these signals become distorted and ineffectual. As a result of the apparent zero market value of these services the producer is unable to incorporate these values into the economic decision making process. Therefore, environmental services are degraded as an unpriced cost of agricultural commodity production.

Agricultural management techniques which are less damaging to the environment can be made more economically attractive by implementing various incentives. Incentives provide the environmental service with an economic value which can be included in the producer's production equation.

The Habitat Enhancement Land Use Program (HELP) was developed to deliver incentives to landowners in the rural municipality of Shoal Lake in western Manitoba. The HELP incentives were designed with the goal of preserving and developing wildlife habitat in harmony with agricultural production (Morgan 1989). These two activities were formerly viewed as an either/or situation, primarily due to the existing economic policies and institutional arrangements associated with the agriculture industry.

The purpose of this study was to evaluate the economic impact that selected HELP land management options have on the participating landowner. In addition, landowner attitudes towards wildlife habitat preservation and the environmental problems associated with agriculture were qualitatively assessed. These findings were incorporated into an examination of how such incentive programs can contribute to a more environmentally and economically sustainable agricultural production system.

METHODS

The study examined only those HELP options which had participant landowners. A literature review and data from the HELP biological evaluation (Jones 1991) was used to appraise the potential wildlife productivity of the study options. A total of 26 participant landowners were interviewed during personal visits, or by telephone, between January 24 and February 12, 1991, to assess the perceived economic value of benefits and costs attributable to the HELP incentives and restrictions. This data was evaluated using basic statistical procedures to determine the economic impact of the incentive option on the landowner. Landowner attitudes and perceptions with respect to the HELP options, and environmental problems associated with agricultural production were collected during the interviews. This data was used to develop a qualitative assessment of option performance.

RESULTS

The HELP options targeted for this study were delayed cut tame forage, salinity barrier, rotational grazing, delayed cut native hay, and land idling. These were the only options which had participant landowners.

The HELP options imposed a range of costs and benefits on the landowner resulting from the relevant incentives and restrictions. The relative potential wildlife productivity and the relative economic impact of each of the study options is summarized in Table 1. The rating of the options is based on the relative performance of each option compared to the other options and compared to conventional management. For example, the delayed cut tame hay option provided fairly strong benefits to wildlife compared to conventional management as a result of the extra time provided for birds to complete the nesting cycle. This option imposed a fairly strong negative economic impact

Table 1. Summary of HELP option performance.

Option	Wildlife Benefits	Economic Impact	Economic Impact (Incl. HELP incentive)
Delay Cut Tame Hay	+ + + +	- - -	- -
Salinity Barrier	+ + + +	+	+ +
Delay Cut Native Hay	+ + +	=	+
Rotational Grazing	+ +	+	+ +
Land Idling	+ + + + +	- -	-

on the producer due to the decreased forage quality from the delayed harvest. The $12.35 per hectare HELP incentive provided was insufficient to offset the extra costs imposed.

The planting of saline tolerant grasses on saline land within cultivated fields also provided net benefits to wildlife. The saline areas formerly imposed a cost on the producer in the form of crop production inputs where there was no financial return. The salinity plantings provided an economic return in the form of forage on land that formerly imposed a substantial economic cost. In addition, there are long-run conservation benefits associated with arresting the steadily advancing soil salinity problem.

The delayed cut native hay option restricts the harvest of native hay (predominantly slough hay) until after July 20. The HELP harvest restrictions required no change in conventional management therefore there was no change in hay quality. An important cost is the loss of field efficiency when farming around these preserved native hay areas. It was found that the producer perceived cost of $48.18 per hectare of slough to farm around these areas was offset by the net value of the hay harvested off these areas. Many of the native hay areas would be un-economic to put into production, therefore the $9.88 per hectare HELP incentive was a minor economic gain for a management technique that would be carried out anyway. As such, the HELP incentive was insufficient to preserve a slough area if there was no returns from forage production.

Rotational grazing provided moderate net benefits to wildlife over conventional grazing management due to an increase in residual nesting cover. Rotational grazing management provided a net economic gain to producers even without the incentive provided by the HELP program. Economic incentives may not be necessary to promote rotational grazing although technical assistance may be required.

Idle lands provide important wildlife habitat across the prairies. The majority of the areas idled through HELP incentives provided no economic returns to the producer in recent years and most of the subject lands were marginal for agricultural production. The $19.76 per hectare HELP incentive was cited as the main reason for including these areas in an idle lease. Using the hypothetical valuation technique for land use restrictions (Bishop and Heberlein 1979) the perceived compensation level necessary to preserve a hypothetical 4 hectare slough was $58.85 per hectare. The HELP incentive was insufficient to prevent producers from draining and clearing these idle areas. The incentive would be attractive only to producers with permanent potholes or areas of marginal land which would not be economic to convert to productive agricultural land. In contrast, idling potentially productive agricultural land would impose an economic opportunity cost on the producer which would not be offset by the HELP incentive.

The study surveyed 26 active producers, whose main source of income was primary agricultural production, and nine landowners whose main source of income was off the farm. Only 11 percent of these non-farming landowners cited purely economic reasons behind their decision to sign a HELP lease. Wildlife was the most important reason cited by 55 percent of the non-farming landowners. This compared to 74 percent and five percent respectively for the active producers. The level of economic is far more important to effect a change in management by active producers than for non-farming landowners.

Soil erosion was considered the most important agriculture related environmental problem by 41 percent of the producers. In contrast, only seven percent of the producers rated loss of wildlife habitat an important problem (Table 2).

DISCUSSION

Economic incentives designed to encourage the adoption of agricultural management systems which are less damaging to wildlife habitat have a range of impacts. The management change may impose a greater financial cost on the participant than equivalent conventional management. The economic incentives must be designed to cover these extra costs if the option is to be adopted. The incentives may be required to more than compensate the producer thereby allowing the producer to make an economic decision to adopt the conservation management technique.

An important component in the development of effective incentive programs is the contribution made towards an economically and environmentally sustainable agriculture. As discussed earlier, agricultural production has frequently ignored or been unable to include as a cost, the environmental damage or externalities resulting from certain production techniques. Incentives are an important tool in assigning value to these extra market costs.

The producer ranking of soil erosion, water conservation, soil salinity, and pesticide pollution far above the problem of loss of wildlife habitat by producers seems to reflect this economic system which ignores off-site costs. Soil erosion, water conservation, soil salinity, and pesticide pollution are perceived as imposing long-run or short-run economic costs on the individual producer. In contrast, the loss of wildlife habitat imposes no perceived economic costs on the producer.

In essence, this is a private cost versus social cost problem. When wildlife habitat is preserved on productive agricultural land the costs, including loss of field efficiency, the opportunity cost of unrealized production, and the depredation of crops by increased wildlife populations, are borne by the producer alone. The social benefits, the various environmental services provided by the preserved area, are enjoyed by all of society. If the area was converted to cropland the producer alone would realize the economic benefits while society would bear the cost of the lost habitat. In general, the individual is unable to assess the total social costs and benefits of development. In addition, the present set of government agricultural policies alter the price regime under which farming operates such that certain types of production are favoured beyond the efficient level in an undistorted commodity market. Policies operate in such a way as to increase unpriced off-farm costs while priced on-farm costs are lowered (Girt 1990).

In conclusion, the movement of agricultural production towards sustainability requires an assignment of values to non-market environmental amenities and off-site costs. The assignment of recognizable value to these costs will make systems which are less damaging to wildlife habitat or have habitat enhancing characteristics, more economically attractive to the producer. The assignment of value to these costs may be accomplished through a number of policy instruments including incentives. Assigning appropriate values to wildlife habitat is just one aspect of this accounting for costs. Wildlife programs may find it advantageous to incorporate other types of policy instruments and encourage government to incorporate directed policies beyond the program's scope. The most important step however, is to develop consistent policies aimed at making agriculture more sustainable and providing a socially and biologically optimal level of wildlife habitat.

Table 2. Producer ranking of agriculture related environmental problems (N = 26).

Environmental Problem	Primary Importance (%)	Secondary Importance (%)
Soil Erosion	41	35
Water Conservation	19	26
Soil Salinity	19	17
Pesticide Pollution	15	8
Wildlife Habitat Loss	7	8
Loss of Species Diversity	0	4

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ALBERTA'S WATCHABLE WILDLIFE PROGRAM AND ITS RELATIONSHIP TO WILDLIFE TOURISM

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INTRODUCTION

Since 1981, it has been well established that wildlife is very important to Canadians and the Canadian economy (Filion et al. 1983). Recent years have seen wildlife agencies across Canada and the United States placing considerable emphasis on documenting the significance of wildlife in a socio/economic context.

In Canada, the federal and provincial governments have cooperatively conducted the 1981 and 1987 Survey of the Importance of Wildlife to Canadians (Filion et al. 1983 and 1987). Some very significant findings have emanated. In 1981 and 1987 respectively, 16.7 and 18.3 million Canadians participated in wildlife related activities which directly contributed $4.2 billion and $5.1 billion to the national economy. From the 1987 survey, it is estimated that $4.0 billion is directly attributed to nonconsumptive wildlife related activities which includes primary trips, incidental trips, residential activities, participation in wildlife organizations, and maintaining, improving, and purchasing natural areas. Public support for maintaining abundant wildlife and preserving endangered wildlife has also increased from 83.3 percent in 1981 to 85.2 percent by 1987. Of particular interest is the amount of time and number of expenditures individuals have devoted to nonconsumptive wildlife related activities. In 1981, residential based activities, by some 12.3 million Canadians, generated an estimated $196.9 million in direct expenditures. In 1987, these same activities increased to 14.0 million participants and $324.9 million in expenditures.

From a wildlife tourism perspective, similar increases have occurred in primary nonconsumptive wildlife-related trips or outings. From 1981 to 1987 the number of days spent on primary nonconsumptive trips increased from 56.8 million to 74.4 million and total expenditures for these type of trips increased from $2.1 billion to $2.2 billion.

The overall results of these surveys have led many wildlife agencies in Canada and the United States to re-examine their policies and programs. No longer are they solely accountable to traditional client groups. New policies, programs, and strategies, are required to provide quality services for complex and diverse client groups while at the same time, maintaining a resource stewardship function. Wildlife agencies' organizational structures have and will continue to change in the '90s. Alberta is no exception.

THE EVOLUTION OF ALBERTA'S WATCHABLE WILDLIFE PROGRAM

In 1983 the Wildlife Branch of the Alberta Fish and Wildlife Division created a nongame unit. The unit was primarily responsible for managing nongame species, and secondly, to provide programming for nonconsumptive users. From 1983 to 1988 many significant achievements occurred in the area of endangered species and nongame management. However, program planning related to nonconsumptive wildlife recreation received little attention. In 1988 the Wildlife Branch was reorganized to reflect changing needs and priorities. As part of this restructuring, a Natural History Section, having two permanent staff, was established to primarily focus on the development and implementation of a nature appreciation program. By creating a specialized section within the Wildlife Branch, it paved the way for elevating the recognition and priority for nonconsumptive wildlife recreation to a level that was comparable to the hunting and fishing programs.

PROGRAM GOALS AND OBJECTIVES

Our first task was to develop a strategic plan which outlined goals, objectives, and mechanisms to enhance public involvement and participation in wildlife appreciation, viewing, and conservation. Five goals emerged:

1. An awareness goal to increase levels of public interest in and appreciation for the wildlife resource.

2. A recreation goal to increase opportunities and participation levels in the nonconsumptive use of wildlife.

3. An educational goal to increase the levels of public knowledge and understanding of wildlife species and their habitats.

4. An economic goal to increase the interest and participation in wildlife tourism in Alberta.

5. A conservation goal to increase public involvement and support in wildlife management programs.

To achieve these goals, objectives were established for each and include:

1. Public appreciation of wildlife: to develop wildlife interpretation materials for public brochures, pamphlets, magazines, and newsletters for promoting nature appreciation through mass media vehicles; to develop wildlife displays and information products to assist nature centres, zoos, museums, and other public venues.

2. Nonconsumptive wildlife recreation: to identify and promote wildlife viewing opportunities by publishing provincial, regional, and urban guides (books, pamphlets); to identify, develop, and manage a selection of designated high quality wildlife viewing sites on public lands; to work with other government and nongovernment organizations, agencies, and individuals to enhance their existing or proposed nature appreciation programs.

3. Understanding and knowledge of wildlife: in cooperation with urban parks, nature centres, schools, and the youth groups, design, conduct, and assist with wildlife education outings, study projects, and courses; to prepare and disseminate information packages and products on wildlife species' characteristics, distribution, abundance, and habitat requirements—these products will be available to educational programs such as outdoor recreation courses, nature centre courses, and school curricula.

4. Wildlife tourism: to design and implement market assessment and user behaviour opinion surveys for wildlife tourism in Alberta; to publish provincial and regional wildlife viewing guides to enhance tourism opportunities; to promote, encourage, and support wildlife tourism initiatives and projects which are of interest to local authorities (cities, towns, and municipalities); to provide encouragement, advice, and support to tour operators, guides, and outfitters in cooperation with Alberta Tourism.

5. Conservation: to encourage volunteer participation and support in programs and projects benefiting wildlife, e.g., Christmas bird counts, wildlife population and distribution surveys, and wildlife enhancement activities; in cooperation with other agencies, organizations, and local authorities, foster and promote wildlife conservation, values, and principles.

PROGRAM ACHIEVEMENTS

By far the most significant undertaking for the program was the publication of the award winning Alberta Wildlife Viewing Guide (Lone Pine 1990). The 96 page book describes over 60 of the best wildlife viewing sites in the province. Complementing the text are full color photographs and maps for each location. For each site, descriptions of species diversity, occurrence, habitat types, and significant features and landforms are included. The kinds of services and facilities at each site are also detailed in graphic form. To further enhance the readers appreciation, enjoyment, and understanding of wildlife, the book contains a section on photographing wildlife and wildlife viewing etiquette. To date approximately 10,000 copies have been sold. The success of this project is attributed to many factors. First and foremost, the project was cooperative-based having many supporting partners and volunteers. Participants took part in all aspects of the project, from site identification and evaluation to the design and writing of the book. Building a sense of common ownership by all was an important factor in its success.

As the viewing guide hit the retail book market, our program became officially launched and was renamed as Alberta's Watchable Wildlife Program. The Nonconsumptive Wildlife Recreation Program sounded like some kind of disease.

With the guide published, our emphasis turned to upgrading the interpretative aspects of wildlife viewing sites. Although the 60 sites were selected on the basis of having some existing infrastructure, it was recognized that both directional signage to access the sites and interpretive signs to enhance visitor enjoyment and appreciation would be necessary. In cooperation with Alberta Transportation and local municipalities, the majority of the sites have been upgraded with supplementary directional signage. Work continues with local authorities and site management agencies to upgrade their respective interpretative features.

In partial fulfilment of our goals and objectives pertaining to increasing public awareness and appreciation of wildlife, several promotional products have been produced including: a watchable wildlife display for shows and conferences; a directory of wildlife viewing references; a program brochure; and an assortment of pins, stickers, and crests. Staff have also made presentations to various public groups, schools, and public shows or events. Considerable emphasis has been placed on encouraging, in cooperation with the Edmonton Christmas Bird Count Organizing Committee, the establishment of Christmas Bird Counts across Alberta. Since 1986, the number of counts in Alberta has grown from 22 to over 50, a good indication of the growing interest in bird watching in Alberta.

To address our wildlife tourism goals, two major studies have been completed. In 1990, a study on "Marketing Watchable Wildlife tourism in Alberta" (HLA Consultants 1990), was conducted, the results of which suggest:

1. Albertans want a strong commitment to resource protection and management if wildlife viewing tourism is to be developed and promoted on a sustainable basis.

2. Albertans, particularly in the southern part of the province want an improved supply of, and access to, public lands supporting a diversity of viewable wildlife species.

3. Alberta Tourism should have an expanded role in land use planning particularly as it relates to travel routes, tourism resources, and protected areas.

4. Since non-resident tourists will demand a high level of expertise and service from wildlife viewing tourism operators, Alberta Tourism should assume a primary responsibility in fostering high standards and skills in the industry.

In 1991, an Alberta Resident Watchable Wildlife User Survey (Manecon 1991) was completed to determine resident preferences and impediments to wildlife viewing and to detail some of the associated socioeconomic benefits. Based on participant activities in 1990 some of the highlights include:

1. Ninety-six percent of Albertans participated in various forms of wildlife viewing and appreciation, while sixty-four percent (64%) participated in a direct and purposeful way through activities at home (providing nest boxes, feeders, and food) or by taking trips for the specific purpose of viewing wildlife in the outdoors.

2. An estimated $350 million was spent on equipment (binoculars, cameras, film, bird feeders, etc.) to aid their wildlife viewing activities and an additional $583 million was spent for expenses related to wildlife viewing trips, including transportation, accommodation, food, and souvenirs. Total expenditures by Albertans for wildlife viewing ($933 million) is fast approaching a billion dollar a year industry—a significant contribution to the provincial economy.

3. Among 11 selected leisure activities, wildlife viewing was ranked fourth.

Much of the information gained from this survey has re-affirmed once again the importance of wildlife to both Albertans and other Canadians. Already we are beginning to see that the wildlife tourism industry is beginning to blossom. Many Alberta communities are beginning to assess the merits of the natural resources within and around their jurisdictions with a new philosophy of conservation and sustainable development. In an effort to diversify their local economies, wildlife tourism is becoming an acceptable alternative. Terms like wildlife tourism, ecotourism, ecomuseums, and natural history trails are becoming common place in both urban and rural communities. Some unusual alliances and partnerships are beginning to materialize. I have just recently reviewed an ecomuseum proposal which involves several north-eastern Alberta counties, nongovernment and government agencies. The project proposes a series of auto travel routes which link many communities together in a common goal of sharing and conserving their natural resources to nurture a potential tourism industry.

I would like to describe another example of how wildlife tourism can be a positive factor in protecting and conserving our natural resources. The town of Bonnyville, in northeastern Alberta, is bordered by the shores of Jessie Lake. Initially, Jessie Lake was perceived by many local residents as a murky, smelly, mosquito infested slough. To others, it was home to a diverse number of breeding and staging birds. Threatened by drainage and possible development, a local natural history and bird watching group have saved Jessie Lake from its inevitable fate. By holding public meetings on the wildlife and tourism values of the lake, the group has convinced residents and town officials that the lake was worth saving and furthermore should be modestly developed to accommodate wildlife tourism.

In summary, it is extremely important for natural resource agencies to act not only as responsible stewards but also, to provide the necessary expertise and guidance in the development of nature appreciation programs and the wildlife tourism industry. Wildlife tourism is helping to underscore the value of wildlife to broad segments of our society. This type of activity can serve as a catalyst for providing public benefits and strengthening individual commitment to the conservation of wildlife for future generations.

ACKNOWLEDGMENTS

The author wishes to thank Geoff Holroyd for the encouragement provided to compile this paper. Appreciation is extended to Harry Stelfox for his editorial comments and to Shirley Trott for the extra effort in typing the manuscript.

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LAND ETHIC

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I'd like to thank the organizers of this conference for inviting me to speak on land ethics. I operate a mixed farm, with my wife and two sons, in the Miami area. Our farm is a mixture of zero-till and conventional tillage, cereal and special crop production, as well as conventional grazing and rotational grazing systems for our cow-calf operation. Our location on the Pembina Escarpment, with its vast wildlife population, makes co-existence a necessity as well as a pleasure. The farms in this area have, from the time of settlement, produced generations of wildlife enthusiasts, whether as hunters, self-taught naturalists, or just plain nature lovers. This influence and farmer concern for wildlife have certainly surfaced in the actions of our local soil conservation group, The Deerwood Soil and Water Management Association. Right from our formation eight years ago, we have attempted to incorporate programs benefiting wildlife along with our on-farm soil and water conservation activities.

In my opinion, it is not only an ethical decision to change our agricultural practices to benefit wildlife habitat. There are compelling economic reasons to do so. Deerwood Soil and Water Management Association's demonstration work promoting reduced tillage, trash management, shelter-belts, and water retention, as well as personal experience gained on our own farm from rotational grazing and comparison tillage systems, has convinced me that wildlife-friendly conservation practices make economic sense for our farm.

In the past, settlement and economics forced farmers to change the natural habitat to what it is today. Under traditional farming practices, we very efficiently produce a seasonal monoculture which, from a wildlife perspective, is a green desert where the crop grows for only 90 to 110 days. The grain is removed very efficiently, leaving little spillage, and all residue is worked down into the soil and incorporated soon after harvest. What used to be year round cover and food sources now has grouped cover for only three to four months of the year, making it totally uninhabitable for wildlife. We now have an opportunity, through soil and water conservation practices, to create a system of agriculture which is both more efficient and more beneficial to wildlife.

I think we are at one of those production crossroads which periodically occur in agriculture. Much like the replacement of horses with tractors, the movement to reduced till, or even zero-tillage, is made possible by technological innovations in tillage and seeding equipment and in good, effective post-emergence farm chemicals.

On our farm we have a tillage trial where, in the same field, we have compared conventional, minimum, and zero tillage over the past five years. We have experienced as much as a ten bushel per acre yield increase in the zero-till over the other two trials. This demonstrates the economic incentive to the farmer to move to reduced tillage practices.

The spinoff benefit of reduced tillage is the habitat enhancement which could potentially occur on the 13.3 million improved agricultural acres. The 1986 census shows a total of 19.1 million agricultural acres managed by only 27,336 farmers in Manitoba. The improved acres represent 69% of the total acres. The ownership data from the census also contains a message. Of the 19.1 million acres, 62.8%, or 12 million acres, is owned by farmers. Of the 7.1 million acres rented or leased by farmers, only 2.3 million acres is Crown land. This means that only 12% of total habitat in agricultural Manitoba can be accessed or policy-influenced by direct government intervention in habitat enhancement. The involvement and cooperation of farmers is therefore vital for habitat improvement. This must be the message that all wildlife agencies and the general public take from this conference.

While preparing for this presentation, my father suggested that maybe the real endangered species is the farmer. This past decade of erratic weather patterns, even more erratic interest rates (we saw our interest financing costs rise from 12% to 22% in one year in the mid 1980s), and the devastating international trade war has decimated our farm population, shrunk our communities, and caused major financial hardship on the farmers still out there. When you begin to compare our farming plight to endangered wildlife species there are many similarities:

Loss of habitat	versus	Loss of market access
Loss of food sources	versus	Low grain prices and high input costs
Competition from introduced species	versus	Export subsidies of European and United States governments

Farmers really could move onto the list of endangered species along with Burrowing Owls (*Athene cunicularia*), Whooping Cranes (*Grus americana*), and Swift Foxes (*Vulpes velox*). It's time for agriculture groups and wildlife agencies to cooperate and work to common objectives. We must remember that farmers and, by extension, all Manitobans are living with wildlife off the bounty of the same resource.

I heard Dr. Rounds interviewed on CBC prior to this conference at which time he stated that there is room in western Canada for both agriculture and wildlife. He offered as examples the North American Waterfowl Management Plan, the Prairie CARE (Conservation of Agriculture, Resources and the Environment) Program, the Habitat Heritage Corporation, and the marginal land programs of both federal and provincial governments, all agencies whose aim is to enhance wildlife habitat while at the same time providing economic incentive and assistance to the farmer as a partner in this endeavour.

We must not let ourselves get side-tracked into this no-win confrontational publicity arena of the extremist animal rights activists. There is too much good work to be accomplished in habitat enhancement with farmers and wildlife agencies working together. Through proper education and good communication, we must ensure that the general public has a clear understanding of this issue. We have too little time and too few resources to waste in futile confrontation.

DEVELOPING A PERSONAL LAND ETHIC

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I tried very hard to come up with a way to start a presentation about land ethics at a conference like this without quoting Aldo Leopold. I must confess to you that I could not. "A land ethic reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land." (page 258). That is how Leopold (1991) describes the land ethic in "A Sand County Almanac." When I hear that description, two phrases stick in my mind: "ecological conscience" and "individual responsibility."

A land ethic cannot concern itself solely with soil conservation, or with water management or with wildlife biology. It must consider all of these plus the other processes that are operating in the environment we are looking at. In addition, the development of a land ethic requires our commitment as individuals. It is not something that can be enacted in legislation nor can it be done for us by someone else. As an old advertising slogan used to say, "If you don't do it, it won't get done."

Now that may sound like a pretty heavy load to get hit with first thing in the morning, so perhaps we should see if we can break "land ethic," "ecological conscience," and "individual responsibility" down into more manageable pieces. Fortunately, we can get some help from Leopold there as well. As he developed the principle of a land ethic, his writings reveal at least some of the thought processes he followed. A couple of other selections from his writing may provide us with some guideposts as we work our way toward an understanding of our own land ethic.

To do that, we must first have a clear vision of what a land ethic is. Leopold left us this view of its fundamental underlying principle: "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. His instincts prompt him to compete for his place in the community, but his ethics prompt him also to cooperate.... The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land." (ibid., page 239).

If we agree with his view, Leopold is telling us that people must first recognize that their place is as a part of, rather than apart from, the natural order. We can probably all accept that on a philosophical basis. It may be more difficult to adopt in practical terms.

Most North Americans no longer have a direct link to a piece of the rural landscape. We have become predominately a population of urban dwellers; a people who, if we look at all, must search for the cause and effect relationships between our individual actions and the natural order. Our view of the world tends to become more narrowly focused as our age, educational level, and life experience increases. We become experts in auto mechanics, in soil physics or in waterfowl biology at the risk of losing our ability to see our place and the role of our specialty in the larger picture.

Our ability to develop a functional personal land ethic will also likely be influenced by economic considerations from time-to-time. It is not always easy to decide to make the ethical choice, especially if there is a financial cost associated with that decision. If we can accept those costs as a measure of our personal commitment to the necessity of developing a land ethic, it may make them easier to bear. If viewed as a personal contribution, those costs will at least provide us some feeling of self-satisfaction. If seen only as income foregone, they'll carry negative connotations and no redeeming features.

That's probably enough discussion, perhaps even more than enough, about the difficulties and costs of developing a functioning personal land ethic. It's time to look briefly at some of the positive steps we might take. Leopold helped to chart that course too when he said, "No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions." (ibid., page 296).

Based on that thought, our first step should be to create a climate where individuals are prepared and able to demonstrate their commitment as easily as possible. Two areas of public concern, education and economics, spring immediately to mind as candidates for that sort of action.

As we have already seen, a simple increase in the volume of education does not necessarily lead to a more holistic point of view. We must also concern ourselves with educational content. Because a land ethic requires ongoing education for living rather than short-term learning for employment, our efforts need not be restricted to the customary elementary - secondary - post-secondary sequence of the formal education system. Nor need we limit ourselves to the teaching techniques normally associated with a classroom setting. Glen will be dealing with some of those other techniques in more detail in his presentations, so I'll leave the rest of that discussion to him. For now, it is sufficient to note that, while it is a necessary prerequisite, formal intellectual education will not, by itself, result in the development of a land ethic. If people are to be stimulated to act, intellect must be combined with passion.

People may also be stimulated into activity by the promise of a reward or the threat of a penalty. As a result, economic considerations could be used to encourage a movement toward a land ethic. As a society, we have taken some hesitant steps in that direction, particularly with respect to punitive measures for violations of pollution control legislation. I would suspect that we would almost unanimously agree that that approach has not been very effective. By their nature, those penalties can only occur after a violation has taken place; a violation which, in many cases, cannot be cleaned up. In those instances, no amount of money collected in fines can undo the harm already done.

To encourage people to develop their land ethic, it would seem to me that a system which rewards appropriate behaviour upfront would be preferable to one which seeks to penalize inappropriate actions after the fact. It may even be possible to combine both systems to produce a more powerful impetus for good. To use a very simple, urban-based example, why not combine incentive payments to those who recycle their household wastes with a clearly visible charge for the collection of non-recycled material? Would that not stimulate a more desirable situation than our current system which sees people pay to have recycled materials picked up and buries the actual cost of garbage collection in property taxes where it becomes an invisible amount?

I'm sure there are many other examples one could cite to illustrate the same point. Let me sum up the discussion on economic considerations with this thought; we must develop creative ways of making appropriate actions both economical and ethical wherever that is possible. Having said that, however, we must also recognize that the ethical choice will not always lead to an economic reward.

At the risk of leaving you with the impression that I have no thoughts of my own about this topic, I would also like to quote from another author who makes that point extremely well.

In "The Wheatgrass Mechanism," Don Gayton (1990) says this about "the earth bond," the term he uses to describe a relationship between man and the environment that is analogous to Leopold's land ethic: "Once I had a prescription for the earth bond. It was simple: I watched the sun rise in the morning and I produced food. The rest followed automatically. That option for my society is now gone, forever, and other means of recreating the earth bond must be found.

There is a balance in all societies between science and myth, reason and the imagination. Mine has its balance profoundly tipped toward the rational: it is not partial to explorations by means of concentrated personal insight and imagination, except within the very traditional and defined disciplines of poetry, painting, or theatre. If we are ever to renew our earth bond, a re-balancing must occur. New bonds with the earth can now only be forged by personal explorations that go far beyond simple analysis and concern, into realms of imagination and myth" (page 146).

Gayton has given us clear direction about what we must do to reestablish our earth bond; to develop our personal land ethic. There is, however, one question which remains to be answered. How do we test our actions to determine if they are appropriate? To answer that question, and to close my presentation, I'd like to conclude as I began, with a final reference to Leopold: "Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." (ibid., page 262).

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THE LAND ETHIC—INSTILLING AND LEARNING TO LIVE WITH A LOVE FOR THE LAND

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The diversity of wildlife and the quality of the natural landscape helps to define Canada as a nation. The value placed on wildlife by its citizens reveals much about the nature of its people. The well-being of wildlife depends on how we choose to use the landscape or alter it to better suit our needs. Our land ethic, now and in the future, will determine the fate of most species of wildlife, not only those that are threatened or endangered today.

A land ethic is essentially a set of principles and beliefs that leads an individual to interact with the environment in a positive manner. There isn't a universal definition of a land ethic or how we might recognize someone who has such an ethic, but anyone who cares about the natural environment seems to have their own understanding of what it means to have one. Those who believe that they have a land ethic also believe that others ought to have one as well.

A land ethic in its simplest terms is a love for the land. It may manifest itself in different ways, but a love for the land is the key element in a land ethic. I have known hunters, trappers, fishermen, naturalists, and botanists to name a few in whom I have perceived a land ethic, but their different values often blinded them to the positive characteristics in others. Many naturalists cannot understand how a hunter could have a love for the land, while hunters may dismiss naturalists as emotional and unwilling to accept the harsh realities of life. Each have their own land ethic, but express it in a different way.

While those who have some semblance of a land ethic debate the finer points amongst themselves, there is still a large segment of society who have no land ethic whatsoever. They fail to see themselves as part of a natural system with which they must interact, like it or not. To make matters worse, a new generation is being raised in an atmosphere charged with environmental rhetoric, but most youngsters choose to spend their leisure time in the shopping mall, rather than in the woods or out on the prairies. Aldo Leopold's insights are as valid today as they were in 1949 when he wrote that "Despite nearly a century of propaganda, conservation still proceeds at a snail's pace; progress still consists largely of letterhead pieties and convention oratory. On the back forty we still slip two steps back for every forward stride" (Leopold 1966, page 222).

Those of us who are concerned about conserving wildlife have to be concerned with how other people think and how they interact with the landscape, because their actions have an effect on the things we care about. We care about what happens on the back forty even if the owner does not. If the private landowner has a land ethic, he or she will choose to use that land in a manner that will benefit or at least minimize the harm done to wildlife. That is good for wildlife, and good for the rest of us. If the citizen at large has a land ethic, he or she will ensure that our collective back forty (Crown lands) are managed to benefit or minimize the harm done to wildlife.

Although instilling a land ethic in others has long been seen as a worthwhile goal, the manner in which this is best done is still widely debated. Judging by the rate at which unfavourable landscape changes continue to be made by people, countless years of propaganda and programs seem to have had little effect. Various approaches have been tried and some have shown success, but it seems that the challenge of instilling a land ethic in others has yet to be adequately addressed.

LEGISLATION AND REGULATION

There may be some who believe that it is possible to legislate or regulate a land ethic. The "No Net Loss of Wetlands" approach in the United States is an example of using legislative authority in an effort to prevent both the private and public sector from destroying wetlands. This "Swampbuster" legislation has had some effect, but it has not been successful in forcing people to adopt a land ethic. Recent attempts to weaken this legislation indicate that there are still powerful forces at work which seek to undermine conservation initiatives. There are appropriate uses of legislation and regulation, but we should be mindful that hearts and minds are seldom won by force.

EDUCATION, EXTENSION, AND INTERPRETATION

If a land ethic cannot be instilled by force, then the logical alternative appears to be informing, provoking, and cajoling people to accept a land ethic. In spite of what those who would educate others say, what they really want is for others to think as they do and act as they might do. It is no wonder that such educators have had little real success. Efforts have been made to introduce environmental education into the school system through programs like Project WILD, and facilities such as the Fort Whyte Centre for Environmental Education in Winnipeg, but it may be another decade before we will know whether or not these approaches have achieved any real success.

Extension, meaning the extension of research based knowledge from field and laboratory to the public at large, has been used at times to help foster the development of a land ethic. The blizzard of information that the Manitoba Department of Natural Resources (DNR) used to throw at the public, however, has diminished into virtual nothingness in recent years. Information is important in developing a land ethic, but it alone will not succeed in effecting widespread change.

Interpretation is any communication process designed to reveal meanings and relationships of our natural and cultural heritage through first hand experience with an object, artifact, landscape, or site. Although I've been involved in wildlife interpretation for many years, I can't recall a single instance where the sorts of things interpreters spend most of their time doing has instilled a land ethic in anyone. Puppet shows, slide shows, nature house displays, interactive video, and other so-called interpretive events may have a role to play in nurturing a land ethic, but they don't generate the spark that is necessary to create one. People have to experience wildlife in a way that stimulates all of their senses—something that wildlife can only do in the context of its natural environment. The venue is as important as the animal itself.

HABITAT ACQUISITION BY THE PUBLIC SECTOR

If we can't buy our way into the hearts and minds of farmers, then there are those who would have us buy them out completely. The government must do what the private landowner is unwilling or unable to do. There are places of exceptional value to wildlife that should be held in the public trust, both for their value to wildlife and people. There should also be places where a tree ought to be able to fall in the forest without anyone hearing it, salvaging it, interpreting it, photographing it, carving their initials into it, or having to raise money to preserve it.

The fundamental question that has to be raised, however, is whether or not we believe ourselves to be rich enough to leave something alone. In order for the public sector to preserve a piece of land, it must first be proven beyond a shadow of a doubt that it is absolutely useless. There must be no minerals, no merchantable timber (unless it is on so precipitous a slope that it cannot be taken even by helicopter), no potential for agriculture, no likelihood of urban or industrial use, and so on.

Once land has been acquired by the public sector, continued vigilance is required to maintain the integrity of an area. Public lands intended for one purpose may later become multiple use areas, and slide into being multiple abuse areas without anyone really noticing. In the absence of a widely held land ethic, no public lands regardless of their designation will be safe for long.

FINANCIAL INCENTIVES FOR LANDOWNERS

Because public ownership has negative implications in rural areas, working with private landowners is often seen as a much better alternative to buying them out. One of many insightful observations made by Aldo Leopold was that "the land-relation is still economic, entailing privileges but not obligations" (ibid., page 218). The people who design habitat programs aimed at landowners accept that landowners are most often motivated by economic considerations and see little need to change that basic equation. The North American Waterfowl Management Plan (NAWMP) is based on the underlying belief that economic forces adversely changed waterfowl habitat over a wide area, and that economic tools can be used to effect positive change. At the risk of over-simplification, the idea is that if the farmer doesn't want to raise ducks on his land, we'll pay him to do it for a while and hope that he likes having them around so much that he'll leave things alone after the payments run out.

As Leopold pointed out, though, "We asked the farmer to do what he conveniently could to save his soil, and he has done just that, and only that. The farmer who clears the woods off a 75 percent slope, turns his cows into the clearing and dumps its rainfall, rocks and soil into the community creek, is still (if otherwise decent) a respected member of society" (ibid., page 224). An example of such circumstances occurred in the late 1980s in Manitoba when wind erosion caused soil to drift into drainage ditches, completely filling many of them. In a move popular with local farmers, the DNR cleaned out the drains at public expense and then gave the degraded soil back to the farmer. There were no penalties to discourage poor soil management practices, and in the absence of a land ethic, no social sanction against this sort of behaviour. Financial incentives that promote conservation will work in the short term, but are doomed to failure in the absence of a land ethic in the long term.

HABITAT CONSERVATION BY THE CONCERNED CITIZEN

More by accident than design, there do seem to be a significant number of people who have a land ethic and have land with which they might demonstrate their beliefs. I have tried this "damn the rest of the world, I'll save it myself" approach and can share what I have learned from my experience.

I acquired a quarter section of marginal agricultural land near Langruth and another at Delta Marsh. Though it looked as if it both of these parcels were pretty much useless for anything, the variety of interest expressed by others in this land over the years has been astonishing. I've experienced trespass grazing, trespassing hunters (on foot, by truck, snowmobile, and all-terrain vehicle), nightlighters, seneca root diggers, and two incidences of arson. I began to believe that anything of value that I had managed to conserve on my property would eventually be taken or destroyed by others. Once again, it seemed that the only solution to these sorts of problems was to foster a land ethic in others.

I also learned that if your land is not only marginal for agriculture, but also deemed to be marginal for wildlife, you will be virtually on your own. There will be lots of free advice available from government and non-government agencies, but if you want to do something for wildlife on these types of lands, it will be at your own expense.

Programs like the NAWMP recognize quite correctly that he who tries to save everything saves nothing. The program targets its expenditures for those townships in Manitoba where there is the best potential for raising ducks. Outside of these areas, the Critical Wildlife Habitat Program may offer some assistance, but normally only for those lands that have tall grass prairie, and in the next few years, mixed grass prairie. Most of Manitoba's privately owned lands would not qualify for any assistance under the current array of incentive programs.

Incentives to clear or otherwise "improve" these lands, however, are available. Haying and grazing income can be written off against taxes and other expenses, while acquiring a wheat board permit book could open up a cornucopia of subsidies and assistance payments. It still pays to destroy habitat. If you want to preserve wildlife on these marginal lands it will cost you.

In spite of the economic disincentives to preserve wildlife habitat, people are digging into their own pockets to purchase recreational land and enhance it for wildlife. Hobby farmers and commuters are excavating ponds and planting native prairie gardens. A few commercial farmers are also setting aside marginal lands on their own initiative and foregoing income as a result. Some have even donated lands to the Habitat Trust or voluntarily protected them under the auspices of a variety of programs. Their land ethic transcends economic considerations, and they do these things because they want to, and enjoy doing it.

These individuals serve as role models and emphasize the benefits of a land ethic. A land ethic remains something everyone should have, and we should do something to see that it is instilled in others.

THE BIRTH OF A LAND ETHIC

In my experience, a land ethic is most often sparked at an early age, though some have indeed discovered it later in life. Recognizing that there are as many paths to the promised land as there are people, the common thread in the creation of a land ethic is a memorable interaction with wildlife. For me, it was an early October morning in Delta Marsh on a duck hunting outing with my father. I was too young to be carrying a firearm, but the sensory experience of the marsh as gaudy Mallards (*Anas platyrhynchos*) swirled around us is fresh in my memory even today. No one intended to instill a land ethic in me that day, but given the appropriate stimuli, the flame was lit.

My counterpart in Alberta, Tom Bateman, can relate a story with a similar result. Many years ago he organized an early morning excursion for a school group to watch Sharp-tailed Grouse (*Tympanuchus phasianellus*) on a dancing ground. It was the first time that anyone had tried such a thing in that school, so there were no rules that said it couldn't be done. They met at the school at the unheard of hour of 4:00 am and set out by bus in the cold darkness. The experience of Sharp-tailed Grouse on a lek, illuminated by the warmth of the rising sun, had a profound effect on those students, two of which later become conservation officers and another a wildlife biologist.

Whether it is a duck scrambling into the autumn air, Sharp-tailed Grouse dancing in spring, or perhaps an Elk (*Cervus elaphus*) bugling in the woods of Riding Mountain, this is this sort of wildlife experience that is most successful in sparking a lifelong interest in the natural environment. This is the point of ignition.

If we really believe that a land ethic is a worthwhile thing for people to have, then we should be developing more and better ways for people to experience wildlife in a meaningful way. The provision of high quality wildlife experiences is labour intensive and requires an intimate knowledge of where and when such opportunities exist. For most organizations, this type of interpretation doesn't increase the visitor statistics nearly as much as would a mall display or a winter carnival, and it doesn't lend itself well to regular working hours, so it seldom gets done. The most effective means of instilling a land ethic is seldom used by anyone in government sponsored programs. A land ethic is still more often than not instilled more by accident than by design.

One encouraging development is the small but growing number of guides and outfitters in Manitoba that are offering nature tours. Parents, teachers, or youth group leaders who have the wherewithal to take advantage of these services and are willing to pay for them, can do a great deal towards generating a land ethic in others. In the past people looked to governments to fulfil a need that wasn't being met, but in future, conservationists concerned about education will have to rely more on private initiatives. It isn't enough any more to sit back and say that the government should do something about it. We should do something about it. It is nice to see that some have taken the financial risk to offer opportunities for others to interact with wildlife. The necessities of financial viability, however, may raise barriers to participation that could be insurmountable by those who are not as well off.

CONCLUSION

As Aldo Leopold suggested many years ago, actions that serve the best interests of the individual landowner do not necessarily serve the best interests of the community as a whole. Instilling a land ethic in others is essential to the success of every initiative aimed at conserving wildlife and natural areas. No one is a born conservationist; conservation is something that is learned. Those of us who concern ourselves with conservation should ensure that opportunities exist to spark a land ethic in others and see that it is nurtured. We will not be able to force or cajole people to develop a love for the land, but we should provide opportunities that will make it as easy as possible for nature to take its course.

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LAND ETHICS - SESSION'S SUMMARY COMMENTS

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It is important to give people exposure to nature if they are to be expected to have some appreciation for it and interest in protecting and enhancing it. Children are especially important to influence through our education processes. They must be able to "see" and to have "hands on" experiences to develop their appreciation and understanding for nature. Too many school nature programs are "set apart" from the general school curriculum.

For adult education in conservation, the power of demonstration is a great tool. Field tours are invaluable.

There is a need for governments to change some of the many policies relating to land that are not "conservation friendly" or were designed with only a single, specific purpose in mind.

Many government programs lack true grassroots input in their planning and design, with resulting fragmentation and ineffectiveness in their delivery.

It is important for landowners to have a stake or investment in projects or activities that involve them or their land to ensure their long-term commitment to it.

Land survey requirements and subsequent costs restrict easy setting aside of parcels of land for conservation or preservation purposes. Effective, long-term conservation easements would be helpful.

In most everyone there is likely a spark of "land ethic" that can be nurtured to fruition with the proper stimulation.

People with a concern for the land and nature must not be disheartened that rapid change does not take place or that others with power are not "making things happen." Each person should go forth in their daily lives doing their small part in action, word, and deed to show and express their interest, commitment, and concern to land ethics—some of it will rub off on others they touch.

ENVIRONMENTAL SCIENCE AT THE UNIVERSITY OF MANITOBA

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I would like to restrict the few comments that I can make to the ways in which the University of Manitoba, and particularly the Faculty of Science at the University of Manitoba, has responded as an educational institution, and is continuing to respond to increasing environmental concerns.

I should like to preface my comments with the opinion that a very desirable precursor to formal environmental education is the creation and fostering of environmental awareness in pre-university young people. Without an appreciation for the beauty of natural systems, for the wonders of biological diversity, and for the elements of the interrelationships of the homeostatic function and structure of ecosystems, I suspect the motivation to enter into further educational programs may be lacking. Without an appreciation of natural systems, how can we expect young people to be concerned about their conservation?

To a very large extent I believe our schools are doing a marvellous job of creating this awareness as indeed are the environmentally friendly lifestyles that are increasing in many homes, but I believe that our universities represent a resource which can help in this process and I do believe that this happens in a myriad of ways. One way in which this happens at the University of Manitoba is through the activities at the University Field Station in the Delta Marsh, where annually close to 1,000 young people from schools throughout Manitoba visit for periods ranging from a few hours to a few days. Activities provided to these classes range from simple demonstration of the diversity associated with a Manitoba wetland to the provision of progressive environmental and ecological exercises. Our Field Station has facilitated this by the preparation of a handbook of possible activities that is freely available to all schools.

A thorough examination of the University of Manitoba's general calendar will quickly provide an indication of the breadth of environmental education that is available and the wide range of disciplines which have something to offer. In a recent internal document prepared by Dr. Tom Booth on environmental initiatives at the university, the author recognized somewhere in excess of 150 courses spanning the faculties of Science, Arts, Agriculture, Engineering, Education, Architecture, and Law. With a little guidance, undergraduate students could quite readily avail themselves of packages of courses in such areas as Environmental Pollution, Conservation, Environmental Toxicology, Natural Resources, Population Structure and Dynamics, Environmental Economics, Environmental Policies, and Environmental Management.

That this is the case should not be surprising for as the massive environmental issues of global climate change, ozone holes, freshwater and oceanic eutrophication, acid precipitation, resource abuse, deforestation, forest decline, extinction and loss of diversity, soil loss and degradation, population pressure, failure of traditional technologies, and the hazards of new technologies have become manifest, and as we seem as a species to have long surpassed the cultural carrying capacity of our little planet, the implications of all of this on a large diversity of disciplines have also become obvious. This has been fuelled by open public concern for the environment, the slow to dawn reality that growth cannot continue indefinitely in a finite system and some political endorsement of the notion that economic development and the environment are inseparable and that economic practices must be socially and environmentally sustainable.

There are many in society who point their fingers at universities and accuse them of being unresponsive to societal needs. I think environmental education is one area in which such an accusation is without justification, and I don't believe that the University of Manitoba is unique in its responsiveness. However, it is one thing to create a plethora of courses that deal with the many and multifaceted implications of environmental concerns, but it is quite another thing to organize some of these offerings into structured programs the students of which can identify themselves as environmental scientists, managers, or economists. It is also another thing to identify and in some cases even create the career openings for young people educated in any one of such possible programs.

The Faculty of Science and the university have recently attempted to redress these omissions by the establishment in 1991/1992 of a 4-year major Environmental

Science Program with an interesting 5-year cooperative option. The 4-year program is seen in Tables 1 and 2 and from this you will see that it is structured around three levels. The first requires a general background and literacy in a fairly wide variety of subject areas. The second requires that students obtain some intermediate depth in fewer areas and the third permits students to obtain greater depth still within biological, physical, or mathematical sciences. This is the program as it presently exists, but it is and will probably always be in some state of flux as areas of greater depth become defined and new ones become recognized as being worthwhile. By this program we have an ongoing solution to the absence of structured and integrated degree programs. But it does not address the second problem of identifying the careers that may be possible for our graduates. Just as the university has responded to environmental concerns by progressing towards the provision of environmental education programs, the labour market must also respond to the public awareness of environmental issues and many companies and organizations are doing this by developing new environmental policies. Resource oriented and manufacturing industries must, and some are, realize that the production and marketing of environmentally friendly products can be beneficial. Industrial technology must increasingly utilize environmentally harmonious processes and be increasingly cognizant of limiting undesirable environmental impact. In both the public and private sectors it is hard to believe that there will not be an increasing requirement for environmental assessment officers, researchers, and planners. That this is indeed happening is evidenced by the approximately 40 companies and agencies that have made an initial commitment to offer employment to students in our Environmental Science Program, making possible the cooperative option that I mentioned earlier. That cooperative option is presented in Table 3, from which you will see that in this 5-year program, students will interspace their course requirements with three to four work terms. The optimistic hope is that a combination of public pressure, real economic incentives, and the contribution of trained environmental scientists will see continued growth in the demand for employees with a strong environmental education—a situation from which we should all benefit, but perhaps more importantly a situation that may ultimately contribute to a less abused environment.

Table 1. University of Manitoba, Faculty of Science, Environmental Science Program.

BACKGROUND REQUIREMENTS
Introductory biology
Introductory University Chemistry
Elementary Statistics for Biological Sciences
OR
Introduction to Statistical Analysis
General Physics
Topics in Physical Geology
Introduction to Physical Geography
OR
Principles of Economics
Introduction of Numerical Mathematics
OR
Introduction to Calculus
OR
Vector Geometry and Linear Algebra
OR
Introductory Computer Science
OR
Introductory Computer Usage
Intermediate Writing and Research

Table 2. University of Manitoba, Faculty of Science, Environmental Science Program.

REQUIRED INTERMEDIATE DEPTH

Principles of Ecology*
Introductory Biogeochemistry
Pollution Biology
Environmental Conservation Issues
Ecological Impact Assessment
Conservation Strategies

Energy Sources: Physical Aspects

Environmental Geology

Introduction to Environmental Economics

OR TWO OF

Geography of Natural Hazards
Geography of Natural Resources
Energy and Society
Climatic Change

GREATER DEPTH

27 Credit Hours in
Biological Sciences (Botany, Microbiology, Zoology)

OR

Physical Sciences (Chemistry, Physics, Geological Sciences)

OR

Mathematical Sciences (Mathematics, Applied Math, Computer Science, Statistics)

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*Usually available as a summer field course

Table 3. University of Manitoba, Faculty of Science, Environmental Science Program.

COOPERATIVE OPTION*
(5-YEAR PROGRAM)
(MAY COMPLETE 4 WORK TERMS, MUST COMPLETE 3)

Year 1	Course Work
Year 2	Course Work
Year 3	Fall - Work Term Winter - Work Term Summer - Work Term
Year 4	Fall - Course Work Winter - Work Term Summer - Work Term
Year 5	Fall & Winter - Course Work

*Due to commence 1992/1993. Contingent upon funding.

ADULT CONTINUING EDUCATION AND FAST TRACK HEALING FOR GROWING ECOSYSTEMIC STRESS

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I am going to suggest that, as environmental pain grows, demand for learning by adults will increase dramatically. University extension programs and a host of other private and public information brokers are rapidly increasing and merging with the television, radio, video, and paper media. In closing, I will briefly describe my program entitled, "Encounters with Saskatchewan's Endangered Spaces."

IS THERE A DOCTOR IN THE HOUSE?

The litany of insults the human race inflicts on mother earth continues to grow day by day. A communal sense of concern, awakened during the '60s, has deepened to one of urgency and anxiety.

Human population mushrooming; harvest of forest, mineral, and petroleum products trying to keep abreast of consumer demands for housing, automobiles, and a dazzle of technological gadgets; energy demands leading waves of pressure to dam rivers, build more nuclear stations, and coal burners; demand for wilderness recreation settings striving to keep pace with increased global mobility; outright pollution such as acid rain and oil spills; habitat losing ground to croplands, industry, and urbanization; biodiversity diminishing; erosion of the ozone shield; soil organic matter and nutrient content being sacrificed to fiscal ends. The list goes on and on as we discover in workshops such as these.

Add to that the broader, more profound complexities and inherent environmental risks of unequal wealth and technology distribution over the globe, increasing polarization of cultural identities and ideologies throughout the world raising risk of conventional warfare and the risk of nuclear warfare. We are suffering acutely from ecosystemic stress.

In our attempts to answer "why," to stop all this, we find that each location-specific wound with its immediate cause becomes dauntingly complex as we discover layers upon layers of more distant causes. The causes of circumstance are overlain by those of history, economy, and politics. These in turn are influenced by the very values we humans employ to wrest a sense of order from what would otherwise be chaos.

We need a doctor in the worst way!

A great deal of ecosystemic fever is generated at the interface of ecology and economics. "Sustainable development": we are familiar with this notorious phrase promoted by the Brundtland Commission. Classical economists are evidently up against the wall for a cure and sustainable development is their last ditch attempt to dissolve a petroleum-based economy in clean, natural water. The Brazil conference aimed to raise this suspect cure to its zenith—upon a world stage of politicians.

In my opinion, the Brazil conference would do better by finding ways to overcome our loss of community. I don't mean community as in church community, or neighbourhood community, or national community, and I don't even mean global human community. But I mean ecological community—in which we share destiny, hopes, pains, and thoughts not merely with people but with wildlife, mountains, prairies, water, air, minerals, and weather. Allow me to quote Stan Rowe (Rowe 1992) in this context, "How curious that every right-thinking person condemns selfishness and egoism in the individual, and sometimes even in the ethnic group or nation, but never in the species as a whole.... We condemn apartheid in South Africa (and sometimes apartheid as practised against members of Canada's First Nations) but discrimination against animals and plants not needed for food or clothing is routinely practised for sport, for testing cosmetics, for investigating human diseases. Why so?"

The answer may be that we have lost our sense of ecological community, our sense of kinship, of respect, of love. Not just any doctor will do, we need a doctor who cares!

BOTTOMS-UP PLEASE: GOVERNMENTS MAKE POOR DOCTORS

I recently proposed to the Deputy Minister of Environment and Public Safety, of the new NDP (New Democratic Party) Government in Saskatchewan, that the province would do well to commence pro-actively preparing nested environmental master plans. I consider this to be an effective instrument to stop incremental suppression of ecologic concerns in favour of development initiatives; far better than reactively attempting to conduct so-called integrated resource management. Three representatives came to discuss this matter.

Following their words of encouragement and support, I learned that government is increasingly wary of top-down decision-making. Instead, it desires to build community support for new directions from the bottom-up. Leadership, in the face of social/environmental change, is risky and ineffective without involving all stakeholders in developing, carrying out, and monitoring government decisions.

The short of it was: don't look to government to hand down the medicine. Democratic governments make poor doctors.

This type of bottoms-up government was recently well demonstrated with the development of the Saskatchewan Round Table on Environment and Economy's Conservation Strategy. From the beginning, input was sought from a broad range of interests: mining, agriculture, transportation, wildlife experts, plant experts, water experts, forestry sector, etc. Although, to my mind, the draft strategy is deficient in content, the interactive, consensus building process must be applauded. It is a process which recognizes that the mind of each individual citizen is a spawning ground for innovative ideas and approaches. It is also a process through which participants learn to appreciate other ways of balancing environmental variables with personal needs and goals.

Dr. Ursala Franklin (Franklin 1990), during the course of her Massey Lectures of 1989, stated her theory of social change; I repeat it here because it nicely captures the spirit of bottom-up decision-making. She calls it Franklin's earthworm theory of social change. In her understanding, social change includes ecosphere healing and has a great deal to do with learning. She said, "Social change will not come to us like an avalanche down a mountain. Social change will come through seeds growing in well prepared soil—and it is we, like the earthworms, who prepare the soil. We also seed thoughts and knowledge and concern. We realize there are no guarantees as to what will come up. Yet we do know that without the seeds and the prepared soil nothing will grow at all. I am convinced that we are already in a period in which this movement from below is becoming more and more articulate, but what is needed is a lot more earthworming."

Bottoms-up government is earthworming. The government is no doctor, the cures start with you and I.

UNIVERSITY EDUCATION AND HARDENING ARTERIES

For both historical and structural reasons, the formal, degree-granting, format of mainstream university departments may not be the best vehicle for responding rapidly to the mushrooming learning needs about ecology and environment.

Most, if not all, institutionalized education sees "learning" in terms of its objectives or outcomes (Botkin et al. 1979). In this view, learning is the process of handing down information from the knower to the learner. This worked reasonably well during a time when change in surroundings was not readily apparent because it was slower and spanned several generations.

By this approach, education institutions were first established by governments of industrializing nations for the benefit of society. Such benefit translated roughly into tailoring graduates to fit into workplace niches. Reading, writing, and arithmetic were the foundation of early curricula because they most directly related to productivity and hence economic well-being. Education was seen to occur only during the early years of one's lifetime. You learn as much as you can handle, and then cross that one-way bridge like a right-of-passage into the workforce to become, henceforth, a contributing adult citizen.

Today, university and community college institutions continue to operate for the most part within this conceptual framework. Their success is evaluated largely in terms of number and species of successfully placed graduates produced at the end.

Today's university students, unfortunately, even were they to learn environmentally healthy values and management skills, do not achieve management positions in society and government for another decade or more in the future. The critical question is, can environmental concerns wait that long. I believe not. The bottoms-up movement of the adult population segment concerned about the ecosphere's state requires a different learning environment.

The fact is, since the 1950s, adult learning demand has increased and is mushrooming today (Waniewicz 1976 cited *in* Thomas 1991, page 27). The reasons are complex; but, the globalization of the individual human mind, as a result of linking all spaces and places on earth by means of communications technology, appears to have much to do with it. With that globalization comes an increasing awareness of global connectedness and hence an increasing concern about the need for global management. In addition, responsible adults feel a growing sense of crisis, urgency. They want information now.

"People have always had learning needs, but these needs have increased greatly today. For most of recorded history, the environment in which human beings lived was determined primarily by natural events. During the past three centuries, however, that environment has become more and more subject to technological control...(and)...control by human decision. Acquiring the learning that will allow us to make such decisions wisely has become vital. Our learning determines our behaviour, and as our behaviour has become all-important to the survival of the planet, so has our learning. Indeed, we have discovered that we have to continue learning throughout our lives." (Thomas 1991, page 2).

Who will provide the education to satisfy this learning? The traditional departmentalized university or college may be unsuited. Their very structures of quite independent faculties and departments appear designed to suit, not so much the needs of learners as, the needs of those industries and professions who await their graduates. New approaches and concepts are therefore, slow to germinate and circulate unless these fit visions of the future held by industry and professions. The university institutional arteries are not nearly as pliable and flexible as they might be.

RUNNING ON THE FAST TRACK: THE FLEXIBILITY OF UNIVERSITY EXTENSION DEPARTMENTS

There appears to be a large-scale, rather silent education revolution underway today. In general, mainstream institutions are being marginalized by learner-driven privatization of education. This privatization is happening simultaneously along several tracks which, once identified, we easily recognize. The media have become immensely powerful information/education brokers. Not only television, but consider the wealth of radio programs such as CBC's "Ideas" or "Sunday Morning" which explore, in depth, a broad range of topics; consider the birth of the video market and the array of newspapers and magazines. Saskatoon's Star Phoenix Saturday edition introduced its educational section called "Prism" less than two years ago. It now offers 12 or more pages of information and commentary which is effectively adult education. A very wide variety of learning opportunities are offered by community associations, city recreation programs, churches, lobby groups, workplace in-services, and private consultants. Add to these, university extension programs, such as that of the University of Saskatchewan with which I am connected.

The diversity of extension programs can range all the way from multi-course certificate programs offered year after year, to one-time events such as conferences, workshops, seminars, or even over the phone direction to people or material learning resources. A great number of programs offered are short-term, much like a community course offered during evenings or on weekends.

A very important characteristic of extension programs is that they can be altered, adjusted, downsized, enlarged, started, and terminated virtually upon a moment's notice. This flexibility is paramount for closely tracking the rapidly evolving needs of adult learners. University extension departments have the ability to run on the fast track.

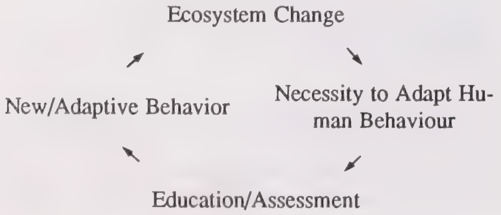
THE DOCTOR WITHIN US: ADULT EDUCATION AND MIDWIFERY

A clear distinction needs to be drawn between learning and education (Thomas 1991, page 17). Learning is the act of an individual driven by personal need, and education is the institutionalized answer to such learning demand. To phrase it in terms of decision-making framework: learning is associated with bottom-up decision-making and education with top-down decision-making. Or again: learning is exploration for and discovery of new ideas and approaches, and education is delivery of set ideas and frameworks.

The important point here is that an increasingly large proportion of education is becoming learner driven as opposed to institutionally driven. The doctor is not out there; not in the government, not of the university or college. The doctor is within each one of us, you and I, searching for cures that ease the pain. The 1984 Council on Continuing Education Unit determined that the purpose of continuing education is to help maintain, expand, and improve individual knowledge, skills, performance, and attitudes, and by doing so, equally meeting the improvement and advancement of individuals, professions, and organizations. Therefore, a primary emphasis is on the individual learner (Mezirow 1984).

I want to add that the Saskatchewan Round Table on Environment and Economy's Education Advisory Committee deserves applause for recognizing the significance of continuing adult education forums as a means to spark its debates and exchange of ideas, and so to expand knowledge more quickly among the adult segment of the population. If we take the time to inquire, to learn, and to act upon our discoveries, then we will not need to blame the government in the future; or anyone for that matter.

Adult education then, is recognized as facilitating learning (Brookfield 1988, page 19). In this capacity, the adult educator has less to do with instruction than with midwifery; assisting the birth of new ideas and fresh approaches. Adult education departments are ideally placed to meet the demand for learning about environment, ecology, conservation, and a host of related topics and issues. It is an opportunity which I hope will be increasingly taken hold of across the globe. The following model describes the environmental change/adult learning cycle.



A 1987 Saskatchewan Education policy framework, Preparing for the Year 2000, identified seven principles to direct the future direction of adult (post-secondary) education within the province (Saskatchewan Education 1987). These principles, clearly written within an economic framework, are worth recasting (with very few alterations I may add) into an ecologic framework, and this makes them read as follows:

1. Adult education is the key to our future ecologic security. It must play a major role in a strategy for ecologic well-being in Saskatchewan.

2. As adult education and retraining become more of a necessity for future employment within an eco-centred economy, access must be provided more equitably to all groups and regions in the province.

3. Adult education is one of the main bulwarks against erosion of the ecosphere. We must reinforce this role.

4. The ability of learners to express themselves clearly and think independently is of critical importance.

5. The highest priority must be given by all adult education institutions to reinforcing analytical, conceptual, and reasoning skills.

6. There must be an expanded focus on the needs of older workers for retraining. Education must become a lifelong endeavour.

7. Adult ecological illiteracy is a silent enemy in our midst. Its eradication must be made a national priority.

ENCOUNTERS WITH SASKATCHEWAN'S ENDANGERED SPACES

I'll take a moment to describe, with appropriate humility, my program entitled, "Encounters with Saskatchewan's Endangered Spaces." It started last spring and is an ongoing ecosystem study. The overriding goal is to enable participants to bridge more or less abstract conceptualizations about ecosystems with real, hands-on field experience of their dynamics. The major sub-goal is for participants to develop stronger commitments and more informed approaches to protecting Saskatchewan's endangered spaces and habitats from threats.

The objectives of this program are that each learner will: 1) obtain an overview of Saskatchewan's ecological zones, ecoregions, and ecosystems—their history and evolution, and their dynamics; 2) better understand how ecosystems function; 3) better understand the functions of organism species within an ecosystem as its environment; 4) understand how complex and variable ecosystem dynamics are in the field; how restrictive and tentative are conceptual models when considered in isolation; 5) appreciate the power of human endeavour to alter, truncate, and/or permanently destroy ecosystem functions and biodiversity; and 6) feel an awakening environmental ethic; feel a new sense of responsibility to be on guard against actions, in the professional workplace and/or at home, that threaten the ecosphere.

Although all interested people are invited to register, I most actively wish to target professionals, land-use managers, engineers, and planners. Most professionals are educated within traditional single-discipline settings and most are therefore, unschooled in ecology. As result, many are ecologically illiterate during a decade of increasing pressure to consider environmental consequences of workplace decisions.

The four foundational lectures which kicked off last year's segment on campus were subsequently published as a book entitled, "Saskatchewan's Endangered Spaces: An Introduction" (Jonker 1992). These lectures were followed by a day of visits guided by Professor Stan Rowe to sites in the Saskatoon vicinity which are representative of Saskatchewan's ecological zones. Subsequently, three overnight field excursions were conducted - Cypress Hills, Grasslands Park, and Athabasca Sand Dunes.

The program is multi-year in the sense that each year a new ecodistrict will be studied intensively, and participants will achieve a thorough appreciation and understanding of these areas and their dynamics over the years. The book serves henceforth as an orientation resource for each new participant in the program.

This year, June 20 to 28, the program will consist of nine days study of Boreal Forest ecology at Besnard Lake in north-central Saskatchewan. It will provide a complete and intensive ecology course of seven professors delivering the following schedule: day 1 - soils, day 2 - fungi, day 3 - insects, day 4 - small mammals, day 5 - large mammals, day 6 - forest birds, day 7 - birds of prey, day 8 - aquatic invertebrates and fish, day 9 - integration and issues. In addition, the program will include a presentation on the past and present relationship of Cree people to boreal forest ecosystems.

Although the days appear rather sharply and traditionally labelled, each instructor is challenged to deliver a program that: 1) is organized around a hands-on research type activity; 2) provides an overview of the range of organisms present in local ecosystems; 3) briefly describes how/why they are so distributed (i.e., with reference to geophysical cycles, habitat requirements, etc.); 4) addresses the effects of seasonal cycles; and 5) addresses some threats to select species.

Participants will come away not merely with abundant new knowledge, but also with a sense of wonder at the immense volume of activity that is occurring within an ecosystem at any given moment in time. The following year, 1993, it will focus intensively on grasslands ecology.

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PROGRAMS IN WILDLIFE BIOLOGY AND ENVIRONMENTAL CONSERVATION AT THE UNIVERSITY OF ALBERTA

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ABSTRACT

The University of Alberta has responded to the challenge of conservation with a growing number of environmental courses and the establishment of the Environmental Research and Studies Centre which coordinates campus-wide initiatives in this area. Two new degree programs, Bachelor of Science (BSc) Environmental Biology and BSc Environmental and Conservation Sciences, have been proposed, the latter for the 1993/1994 calendar. Strong post-graduate programs with specializations in Wildland Recreation, Wildlife Productivity and Management, Range Science, Rural Economy, Forest Science, Botany, Geography, and Zoology are available for Master of Science (MSc) and Doctor of Philosophy (PhD) candidates. The Faculty of Extension offers programs in Protected Areas Management, Environmental Education, and Agriculture and Forestry. Despite budget cuts, the University of Alberta is renewing its commitment to prairie conservation.

Courses in wildlife biology and management at the University of Alberta traditionally were offered through line departments. The first courses dealing with wildlife biology and management were offered by the Department of Zoology. But, with the establishment of a forestry program in the early 1970s, this lead was followed by a growing number of conservation courses in the restructured Faculty of Agriculture and Forestry (Table 1).

Table 1. Selected courses dealing with environmental conservation.

AGEC 435	Agriculture and forestry law
ANSC 376	Wildlife productivity and management
CNST 402	Canadian environmental policy and law
CNST 403	Environmental impact assessment
FOR 260	Conservation and recreational use of wildlands
FOR 365	Forest wildlife
FOR 372	Forestry and the environment
FOR 401	Wildlife impact assessment
FOR 462/3	Wildland recreation management/planning
FOR 464	Conservation/management of endangered species
FOR 472	Human factors in wildland resource management
GEOG 452	Arctic ecology
GEOG 466	Boreal ecology and northern development
LAW 553	Environmental law and policy
INTD 365	Natural resource economics
INTD 369	Economics of the environment
INTD 467	Heritage interpretation
PHIL 266	Philosophy of the environment
PLSC 356	Range/habitat management
PLSC 406/7	Range plants
PLSC 471	Rangeland management
RLS 452	Parks planning/management
SOILS 360	Soil conservation and management
ZOOL 260	Man and the biosphere
ZOOL 354	Wildlife diseases
ZOOL 467	Wildlife conservation
ZOOL 468	Problems in wildlife conservation

Despite long-standing interest in providing such courses, there always has been reluctance to develop specific degrees, majors, or specializations. The reasons may or may not have changed. The highly centralized nature of wildlife administration offered few employment opportunities for graduates. Most positions were filled with holders of advanced degrees, so emphasis was placed on graduate programs which built upon general degrees in Arts, Science, Agriculture, or Forestry.

An exception was the Grazing Management Program, an undergraduate specialization for students pursuing degrees in Agriculture or Forestry. This program prepared students for careers with agencies dealing with public lands, forests, and wildlife, or as ranchers, farmers, and agricultural extension specialists. This program has always been quite successful in placing graduates largely because they were given a broad practical background which offered a wider career choice.

However, the 1990s have brought restructuring of our program, partly in response to falling budgets and partly to perceived shifts in societal needs. A campus-wide Environmental Research and Studies Centre was created to coordinate initiatives in environmental teaching and research. The Faculties of Science and Agriculture and Forestry have proposed complementary new programs relevant to the conference theme; prairie conservation and endangered species. Both programs are under review and undoubtedly will assume a slightly different final form.

ENVIRONMENTAL BIOLOGY

The Departments of Botany, Entomology, Geography, and Zoology are proposing BSc specialization and Honours Programs in Environmental Biology. This will prepare students in the Faculty of Science for careers in ecology and related areas of the life sciences. The program will be implemented initially by drawing from existing courses. The anticipated enrolment is 10 to 15 students/year/class in the Honours Program and 30 to 40 students in the specialization program.

ENVIRONMENTAL AND CONSERVATION SCIENCES

The BSc in Environmental and Conservation Sciences is one of five new degree programs resulting from a major reorganization of the teaching program of the Faculty of Agriculture and Forestry. It will be offered along with baccalaureate programs in Agricultural Sciences, Food Science, Forestry, and Agriculture and Food Business Management.

Complementing the life science focus of the Environmental Biology degree, the BSc in Environmental and Conservation Sciences is a broadly-based degree emphasizing the integration of natural science, management, and social sciences as applied to environmental issues. Graduates will have the ability to evaluate impacts of land use and industrial activity on soil, water, plant, and animal resources and to implement conservation measures and remediation strategies for natural and damaged ecosystems. They will also understand the role of social, economic, and political forces in natural resource management.

Students for the five degree programs in Agriculture and Forestry will have a common structure including: 1) a common core of four half-course equivalents (HCE) to provide a broad university education, 2) a natural science or social science common core, and 3) a core for each degree program (Table 2). Students then select courses (up to four HCE program requirements and six HCE electives) from one of six areas of concentration.

Land Remediation, Reclamation, and Conservation

This concentration combines the natural and applied sciences with emphasis on understanding and minimizing anthropogenic impacts on the environment. Graduates will be able to design and implement programs to maintain quality environments and restore damaged ecosystems. Program requirements include: methods of environmental sampling and analysis; land remediation, reclamation; soil and water conservation; soil environmental chemistry.

Environmental Economics and Policy

Students choosing this concentration will develop skills in economic analysis of environmental problems and the policy process associated with environmental issues. Graduates will be prepared for careers in government and private industry in environmental economic analysis, policy analysis, and related areas. Program requirements include: natural resource or

Table 2. BSc Environmental and Conservation Sciences curriculum.

	Faculty core	Natural science core	Environ/Conserv science core	Environ/Conserv concentrations
Quatitative methods	9			
Communication	3			
English	3			
Basic life sciences	6		6	
Basic social sciences	3			
Economics (macro/micro)	6			
Ecology	3			
Engineering	3			
Systems/Conservation	3			
Human resource management	3			
Enrichment electives	12			
Chemistry		6		
Resource assessment			12	
Environmental impact assessment			3	
Environmental philosophy			3	
Environmental policy			3	
Environmental resource economics			3	
Concentration requirements				12
Concentration guided electives				18
Total	54	6	30	30

Single term course (half term equivalent, HCE) is 3 units. Students take 30 units per year for a total of 120 units in the 4-year program.

environmental economics, environmental law, and environmental policy.

Wildlife and Rangeland Resource Management

The Wildlife and Rangeland Resource Management concentration introduces the theory and practice of managing soil/plant/animal relationships. Students will have an understanding of multiple uses of wildlands and the integration of wildlife conservation with agriculture and forestry. This stream deals with means to increase the productivity and diversity of wild plants and animals. Graduates will be prepared for careers with government agencies or private firms dealing with management of wildlife, rangelands, and forests. Program requirements include: rangeland plants; range/habitat management; wildlife biology/management; rangeland systems.

Conservation Biology and Management

This concentration emphasizes stewardship of protected areas and critical ecosystems. The program emphasizes understanding, planning, managing, and communicating the complex ecological relationships of natural environments; securing their ecological integrity and facilitating, where appropriate, their use for outdoor recreation, ecotourism, and environmental education. Career opportunities include government, environmental agencies, private corporations or consulting firms concerned with forestry, parks, nature reserves, recreation areas, fish and wildlife, or ecotourism. Program requirements include: environmental interpretation, protected areas management, conservation biology, protected areas planning, or endangered species.

Independent Concentration

In addition to the five formal counselling streams, students will be able to design a program which will match their special interests. This program must be pre-approved and based on consultation with an advisor.

Graduate Research and Training

Advanced degrees (MSc and PhD) in environmental conservation are offered by the Faculty of Graduate Studies and Research through the Departments of Animal Science, Botany, Forest Science, Geography, Plant Science, Rural Economy, Soil Science, and Zoology. Most departments do not have identified specializations but these submitted in at least three departments have specific designations: Wildlife Productivity and Management (Animal Science), Range Science (Plant Science), or Wildlands Recreation (Forest Science).

The University of Alberta always has had a strong northern focus facilitated by the Canadian Circumpolar Institute. However, as programs in sustainable agriculture and forestry strengthen, attention is turning to prairie ecology and conservation.

The University operates several field stations including the Meanook Biological Station in the boreal zone, Ministik Wildlife Research Station and Kinsella Ranch in the aspen parkland, and the R.B. Miller Biological Station in the southern foothills. These offer exciting research opportunities for staff and students.

EXTENSION PROGRAMS

The Faculty of Extension administers environmental extension programs in three areas: Environmental Education, Protected Areas Management, and Agriculture and Forestry. Besides hosting workshops and conferences on a variety of environmental themes, the Faculty of Extension has published a number of important titles on conservation and sustainable rural development.

FUTURE

Despite financial constraints and vertical cuts of several units and programs, the University of Alberta has reaffirmed a commitment to environmental research, teaching, and extension. A new slate of courses and two new degree programs await prospective undergraduate students. The graduate research program's strong northern focus is beginning to turn to the urgent challenge of managing the prairie landscape. By integrating environmental conservation into a professional faculty of agriculture and forestry, we hope to address the questions of sustainability raised by the Science Council (McEwan and Milligan 1991). In designing the curriculum for our environmental degrees, we hope to prepare graduates for future challenges (Romesburg 1991).

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THE ROLE OF ZOOS IN CONSERVATION OF ENDANGERED SPECIES

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HISTORICAL PERSPECTIVE

Over 3000 years ago zoos and botanical gardens had their first beginnings in countries such as China and Egypt. The purpose of these collections was not for any virtuous or intellectual reason, but they were mainly a symbol of power and wealth. They were simply collections of curiosities, in the same manner as these wealthy rulers collected jewellery or art. Botanical gardens were also collections, but had a higher purpose. Collections of plants were often associated with medicine and improvement of crop production.

Throughout the middle ages animal collections continued to be associated with royalty and private amusement or wealth. Botanical gardens became associated with research and education. What about aquariums? The collection and breeding of fish began in the orient and is of ancient origin. It is interesting to note that the fish were bred for the colours and patterns on their backs, since glass aquariums had not been invented, fish were housed in ponds and viewed from above.

Zoos continued to expand with the exploration of other countries and the building of empires. New species from new lands were shipped back to the capitals of the empire as curiosities, and even for public spectacles. But for the most part, these zoos were simply collections of animals. Little or no research was done on any of the animals and as they died, they were simply replaced by others from the wild.

Public zoos began with the advent of the Zoological Society of London in 1826 and the development of the London Zoo two years later. Given the conditions of the people of London during this time, it was not surprising that the zoo was seen as an escape and provided entertainment for the public. Some research was done in conjunction with these early zoos, but it was generally field research. Very little research was done in the zoo itself. As well, most of the animals came from the wild.

ZOOS TODAY

Today, public zoos are still in the process of change. There has been a definite shift from the purpose for entertainment to purposes relating to education, conservation, and research. This change is partly due to the public's demand for a more responsible manner in which zoos deal with their animals. It is not acceptable to have a zoo which is simply seen as a collection of animals for the sake of the collection itself. This is not to say all zoos are pure and wonderful. There are a number of ethical questions which even the most modern zoo has to ask itself, and there are still animal collections whose purposes are unclear and perhaps suspect.

ZOOS AND CONSERVATION OF ENDANGERED SPECIES

It is only within the last 15 to 20 years that zoos have taken a role of any kind in the conservation of endangered species. Breeding programs have existed for some time, but coordinated breeding programs aimed at sustaining animal populations for zoos is relatively recent. One reason for this relates to changes in laws which have restricted the movement of certain animal species. An example of this is CITES (Convention on International Trade in Endangered Species). It has become not only a moral issue to take animals from the wild, it has become a legal issue as well.

The moral issue has also helped to create the need for zoos to take a stronger role in conservation. There has been a trend for people to be more concerned with the welfare of animals as a whole. Caged animals were perceived as unhappy "prisoners" living their life in captivity, to provide amusement for humans. Zoos had to have a greater purpose. This helped to cause many zoos to rethink their mission and become more sensitive to a direction related to animal welfare, research to improve the conditions of zoo populations, research into captive breeding, conservation efforts, and education. This mission has evolved to where zoos are seen as "arks" for the preservation of some endangered species, and even more recently, as keystones in providing education to help conserve the planet.

WHAT ARE THE ZOOS (AND AQUARIUMS) DOING

Education

A key element of every modern zoo is their education program. Programs were once directed toward teaching specifics about animals in a formal classroom setting. This branched out to include more informal education or interpretation of the zoo animals to the general public, and to outreach programs. Today the modern zoo sees the educational mission as a key element of almost every facet of its operation. Design of exhibits is done with regard to its educational value, and all programming has an educational element. As well, the education theme has progressed from discussions specific to individual animals or species, to themes relating to environmental systems and the role man plays in these systems.

In 1986, the Association of International Zoo Educators resolved that it would adopt the World Conservation Strategy, and encourage all educational programming to include conservation education. Today many zoos have educational programs with specific themes relating to conservation, endangered species, and the wise use of our earth's resources. There is also an attempt to provide opportunities for the public to actively help with conservation projects.

One of the reasons that zoo education plays such an important role in conservation education, is found in the type of audience that comes to the zoo. Research shows that in North America, more persons go to zoos than go to all sporting events combined (estimated at over 25 million). Most of these persons are going to the zoo for recreation and entertainment. Very few go for an education experience. Therefore, through creative educational programming these people can be: made aware of their impact/relationship with the environment; can be induced (or seduced) to become interested in the environment; can be induced to do something about problems which face the environment.

This is a great, but important challenge. By showing zoo visitors an endangered species within their area, and by catching their imagination and interest, the visitor can be stimulated to care, and do something to help the species.

There are some excellent examples of zoo and aquarium educational programming here in Canada. The Vancouver Aquarium is a world leader in aquarium education and its innovative approaches are often followed by other major aquariums. An example is their aquatic animal "shows." These have evolved from true shows showing how killer whales do "stunts," to being one of the first aquariums to interpret these shows and change them to where today staged shows have been stopped and the whales are interpreted doing what they do naturally. The aquarium is a leader in the "systems approach" to education. That is their education/interpretive programs show the whales as part of a system, rather than as individuals. This is a critical element in conservation education; trying to get the public to think of the animal as part of an ecological system, rather than as a separate entity.

Some other conservation education programs taking place in Canada include education related to the Peregrine Falcon (*Falco peregrinus*) reintroduction program, Swift Fox (*Vulpes velox*) and Burrowing Owl (*Athene cunicularia*) programs, organized trips into the wilds at home and abroad to see the wild animal as part of a system, and recycling programs, to name a few.

RESEARCH

Captive Breeding Programs: The Zoo as a Modern Ark

Almost all zoos have some kind of captive breeding programs. Some of these programs are designed for the purpose of providing animals for sale to other zoos without depleting the wild populations. Other programs aim at trying to raise an endangered species for reintroduction to the wild.

Some examples of animals raised for this purpose include the Hawaiian Goose (*Nesochen sandvicensis*), the Golden Lion Tamarin (*Leontopithecus rosalla*), the California Condor (*Gymnogyps californianus*), the Swift Fox, and the Burrowing Owl. There are a number of others. The key to these programs is the reality of having somewhere to release the animals back into the wild as in many cases their habitat is minimal.

Conservation Centres

Some zoos have developed separate facilities to do reproductive research. An example of this is the Cincinnati Zoo's Center for Reproduction of endangered wildlife. The objectives of this centre are to: preserve and propagate those plant and animal species that are, or soon will be, at risk of extinction; to set a standard for research in wildlife reproduction world wide; to provide a central focus for efforts that will one day link international conservation initiatives; to give testament to the fact that the people of the Cincinnati Zoo care enough to provide this vital stepping stone to our children's future.

Research in the Wild

Places like the Zoological Society of New York have a history of doing research in the wild relating to endangered species. An example of this is the work of Dr. Schaller relating to the Giant Panda (*Ailuropoda melanoleuca*). Persons from Calgary and the Calgary Zoo have worked in China assisting with projects relating to the Giant Panda. Many zoos cooperate closely in field research undertaken by their provincial departments of natural resources both in Canada and the United States.

Sponsoring Research or Programs Related to Endangered Species

A number of zoos help collect money for research or other programs, or provide funding for research. As well some of the zoological organizations such as the American Association of Zoological Parks and Aquariums (AAZPA) or American Association of Zookeepers (AAZK) promote and fund conservation research and projects.

Examples include the AAZPA's Conservation Center which acts as a coordinator of conservation projects on behalf of a number of its member zoos. In 1990/1991, 69 AAZPA member institutions sponsored 388 projects in 63 nations on six continents. These included 131 species specific projects (conservation, ecological research, reintroduction, and management); 82 projects related to habitat conservation, 45 projects relating to education; and 69 projects relating to rescue and reintroduction of native wildlife.

Other examples are AAZK's Bowling for Rhinos program which raises money to help protect the Black Rhino (*Diceros bicornis*) in the wild, and their Ecosystem Survival Plan program raises money for habitat conservation in cooperation with the Nature Conservancy.

SPECIES SURVIVAL PROGRAMS (SSP)

The SSP, although somewhat controversial, has been designed to attempt to coordinate international breeding programs so as to maintain the genetic diversity among endangered species in captivity. It is based on cooperation of the zoo community and the fact that the animals, that are part of the program, are shared amongst the zoo community. The animals are loaned between zoos so that the best possible matings can occur.

The program is administered by the AAZPA. There are approximately 54 species of animals listed as part of the SSP program.

STUDBOOK

The studbook is another way of keeping data of animals in zoos to enable lineage analyses and to maintain gene pools. There are approximately 36 species in which International Studbooks are kept, and approximately 73 species which have North American Studbooks are kept.

DO ZOOS MAKE A DIFFERENCE?

Over the last decade, zoos have been taking a more responsible role in the conservation of endangered species, and it can be argued that they are key to helping to preserve endangered species.

A discussion followed centered around this paper's presentation of the value of zoos for the conservation of animal species. Although some questioned the realistic value of that role in the long term, many persons felt that zoos could play a crucial role in conserving the breeding populations, and in helping to make the general public aware of the need to preserve our earth's ecosystems so the wildlife has somewhere to live.

CONSERVATION RESEARCH IN THEORY AND PRACTICE

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SUMMARY

The contribution of research toward biological conservation is limited because: 1) decisions regarding the environment are usually made outside of the realm of science (e.g., Aikenhead 1985), 2) science, even at its best, has pertinent limitations, and 3) the structure and reward system within which scientists operate does not fully encourage the practical application of science to solve societal problems. The premise of this presentation was that recognizing and understanding existing limitations is constructive. The following is not meant to suggest that the scientific way of knowing should be rejected, but to caution that too much reliance on this way of knowing alone can be detrimental.

Western society's reductionist approach to science is one in which a system that is too complex to comprehend in its entirety is reduced to smaller parts. These parts are then subjected to experimental manipulation aiming to identify basic forces, their relative strengths, and their interaction. This assumes first of all that complex natural systems can be understood and that all knowledge converges on "one truth." Problems with the reductionist approach can arise at many levels. In theory this approach, comes into conflict with the "modern view on science" which postulates that: 1) no part of a biological system exists in isolation, 2) unlike machines, living systems are in a constant state of change, 3) changes in living systems occur as a result of a balance between anabolic and catabolic forces, 4) the accumulation of small quantitative changes can lead to a qualitative change, and 5) the whole is greater than the sum of parts as a result of the interaction of parts. For example, if biological systems do not exist in isolation, this raises questions about the validity of forming conclusions based on the study of a part of a complex system. T.S. Kuhn (1970) provides a partial solution to this problem by suggesting that individual scientific conclusions can be contradictory, but in their entirety they can combine to reflect reasonably reliably on a larger concept or paradigm. This has relevance for the conservationist, because it would lead one to rely less on the so-called "scientific facts" arising from individual studies and more on the larger concepts which can be used to formulate conservation strategies.

The reward system that has evolved to support the scientific enterprise does not fully lend itself to the solving by scientists of societal problems (Barnes 1988). G. Holton (1988) divides science into many facets, distinguishing among others between sociological (pertaining to norms and values cast by scientists for scientists) and cultural aspects (pertaining to society as a whole). Historically, in order to survive in the tumultuous Middle Ages, the emerging scientists were forced to abrogate their responsibility in matters of the state and the church (Mendelsohn 1976). It is probably for this historical reason that many modern scientists feel that it is their sole responsibility to seek to understand an "objective order of reality" and not to question the supernatural, nor to intertwine the scientific endeavour with societal/cultural problems. Many scientists are reluctant to become fully involved in attempts to solve problems that are perceived by society as a whole.

It is probably no coincidence that humans in western society, who sought dominion over nature, placed great value and confidence in the scientific way of knowing. The assumption that knowledge affords power is inherent in an attitude toward nature that can be referred to as "geodominance." Increasingly, there are calls from people in all walks of life for a shift in thinking from geodominance to "geopiety." This shift in thinking, which is pioneered in elementary and secondary education, should also take place in higher institutions of learning including the scientific community.

Human dominion over nature has proceeded so far with effects so devastating, that in order to conserve the diverse biological life on earth, conservationists must act before they can hope to understand (even if this were possible) the system they aim to preserve. In many cases, a call for greater understanding with the hope to dominate a system, knowingly or unknowingly, thwarts progress in conservation. A cautious approach to resource use and critical examination of human action toward nature may promise more success than our heretofore espoused aim to use science to

dominate nature for human benefit, and at the same time try and use the perceived power of science to keep the life support system alive.

Conservationists, or that segment of society that has a primary interest in preserving the earth's life support system and biodiversity, should assume the power that is now largely vested with scientists. It has been wrongly assumed that "good conservation strategies" flow directly from "good science." Applied engineering knowledge also did not flow freely from the disciplines of chemistry and physics; the practical application of strategies appropriate for engineering required its own knowledge system (Vincenti 1990). Conservationists should devise strategies by relying partially on science but more importantly incorporate other forces from society (the power of the individual, legal institutions, financial institutions, political institutions, industry). Conservationists should form a new social and professional entity and develop strategies for greater harmony between humans and nature.

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THE IMPORTANCE OF RESEARCH IN CONSERVATION

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The message of this paper is that research is the cornerstone on which all conservation action should be based. Conservation action, in the absence of a sound scientific basis, though well-meaning, may have deleterious consequences.

To build the argument, let's consider some definitions. First, what is research? To some, it is a very general term that describes the process of finding an answer to a particular question or problem. Quite a range of activities can fit into this broad category. For instance, discovering which gene is responsible for the onset of arthritis is clearly research but so is checking the "T.V. Guide" to see what time the hockey game is on tomorrow.

To others, research is a specific process, the application of a particular methodology, called the scientific method, for answering questions. The method consists of: (1) the defining of a testable null hypothesis; (2) the assessment of alternative explanations or hypotheses; (3) the collection of data to test the hypothesis; (4) statistical evaluation, of the data; and (5) statement of conclusions which either rejects or provide support for the null hypothesis. Interestingly, this doesn't exclude the T.V. Guide as a research tool. Our testable null hypothesis might be "That the frequency of Star Trek repeats is no different than the frequency of appearance of new episodes." Checking the T.V. Guide for a fixed period of time, we can determine the number of shows in each category, transform the frequencies to approximate a normal distribution, perform a t-test or equivalent and evaluate our hypothesis. This may not be science, but it is research.

A useful way to categorize research is to consider three types.

Summative Research

The consultation of bibliographic sources—a literature search.

Applied Research

The collection and analysis of data following an existing methodology or protocol. Examples are the collection and analysis of visitor survey data in a museum, or the collection and analysis of breeding bird survey data.

Basic Research

Despite the adjective, this is original, often complex, work where the collection of data may, or may not, follow an existing protocol, but the question being asked has not been answered previously. Examples would be the investigation of taxonomic relationships among a group of birds using a new molecular genetic technique, or an assessment of why female owls are bigger than male owls.

Why spend so much time on the definition of research? I think it is necessary to avoid arguments about the value of research based solely on different interpretations of the word.

Let's look briefly at summative research. I doubt there is anyone who questions the value of a thorough review of the literature prior to undertaking any conservation project. Certainly, in Canada, we can benefit from American or European experience in forest and grassland preservation. I know a few people who would suggest that, looking at how others have attempted to answer a question, might stifle their own creativity. Sometimes you hear of people being too close to a problem to see an easy solution. While this may happen on occasion, I suspect that it is the people who are close to a problem that would realize the value of an outsider's suggestion. Using a trial and error methodology, without taking advantage of existing knowledge, is invariably a waste of research time and money.

To assess the significance of applied research, I'd like to consider the value of studies which simply document the occurrence of species in a particular region. An interesting comment comes from an early publication on Canadian birds. Montague Chamberlain of New Brunswick compiled the first *Catalogue of Canadian Birds* in 1887. In his preface, he states "This latter portion of the work (on geographical distribution) has not been accomplished very satisfactorily, for, although considerable labour and care have been devoted to the preparation of the notes on distribution, they are not at all complete, and I fear that on further investigation, some of them will be proven incorrect. All the information that is now obtainable has been procured. But the greater portion of the country - immense stretches of forest and prairie and sea coast - have received little attention from Ornithologists. I am quite aware that this opinion regarding the narrow limits of our knowledge of Canadian Birds is opposed to that held by some of the leading scientific men of the Dominion, who consider that all that can be learned about our fauna is now known to science."

We can all chuckle self-indulgently at the arrogance and ignorance of whoever these "leading scientific men of the Dominion" were. But what would be the response of granting agencies today to a request for research funds to support distributional studies on the birds of Alberta? I suspect they would sound much like their counterparts of a century ago. To what extent do we know the distribution of the breeding birds of a province like Alberta? Back in 1887 we would have used Chamberlain as our authority. More data and collections from Alberta were brought to light by Macoun and Macoun in 1909 for inclusion in their *Catalogue of Canadian Birds*. Egg collectors and Percy Taverner's collecting efforts in Alberta provided material for his 1926 *Birds of Western Canada*. Thirty-two years elapsed before the next compilation of *Alberta Birds* by W. Ray Salt and Bert Wilk. Godfrey in 1968 in his *Birds of Canada* referred to only 13 papers on the distribution of Alberta birds written after Taverner's book in 1926. Minor changes were added in 1976 for the last revision of the *Birds of Alberta* by Salt and Salt. Now we have the *Atlas of Breeding Birds of Alberta* (Semenchuk 1992).

What strikes me is that there are relatively few studies which document the breeding bird distribution in the province. It is fair to say that about 20 major papers have supplied the bulk of information appearing in the most recent guides. Part of this has been the result of a shift in emphasis from "Birds of" types of studies to ones detailing breeding ecology, physiology, behaviour, and systematics. The feeling back in 1887, that we know all we need to about this aspect of Canadian fauna, seems to have been echoed by researchers and granting agencies in the last 35 years who dismissed these studies as passé.

In another context, how often today do we hear politicians or developers devaluing the need for additional baseline studies or research. It is understandable that political leaders are required to make decisions before answers are available on all issues relating to an environmental problem. It is unacceptable, in my opinion, that the scientific community dismiss the need for baseline, descriptive research to devote available monies to more theoretical, leading-edge work.

In studies of biodiversity, the key question is: "What species can be found in our study area?" In the case of birds, which are the most visible faunal group, the presumption would be that this is a summative research problem—in other words we could just look up the answer. A couple of studies conducted by the Provincial Museum of Alberta in two remote regions of northern Alberta (McGillivray and Hastings 1988, 1990) and more importantly the five years of data collecting for Alberta Breeding Bird Atlas project, convinced me of the need for and the value of applied research on bird distributions. The studies showed that in northern Alberta, species such as Mew Gulls (*Larus canus*) and Parasitic Jaegers (*Stercorarius parasiticus*), typical of more northern sites, may be regular breeders or visitors.

The atlas work is producing convincing evidence of shifts in bird distributions, as a result of human activities and anomalies in the distribution of particular species, not apparent in the broad range maps of previous compilations.

What is apparent in summary is two things. First, detailed knowledge of distributions, habitat requirements, and breeding sites for birds in Alberta is still lacking. Second, these relationships are changing and will continue to change thanks to direct human factors such as logging, agriculture, and urban spread and indirectly through climate change or pollution. There is nothing new in this, only the comment that there needs to be a place for applied research that produces species lists and atlas style reports because the data from these studies will always be critical for decision-making.

Pure or more theoretical research is also essential for sound conservation. An area in which we still lack much knowledge is land management. An oft-stated but overly simplistic view of land management goes like this; "set aside some land, let natural processes work and species will be maintained." The key to biological diversity is habitat preservation. The problem is that we might set aside a piece of land because of what it is today. But in many areas, like the grasslands of southeastern Alberta, if left alone this land will change in response to many factors such as fire, lack of grazing, variations in rainfall, and invasions of woody shrubs. These changes, although natural, may eliminate many of the species or communities that prompted the initial establishment of the reserve. What do we do? As land managers, we might have a particular goal in mind but that goal is rarely compatible with other objectives. Do we accept predator control such as shooting of Coyotes (*Canis latrans*) as the price of successful reintroduction of Swift Fox (*Vulpes velox*)? Do we eliminate grazing to assist Baird's Sparrows (*Ammodramus bairdii*) and thereby reduce habitat for Mountain Plovers (*Charadrius montanus*)? Do we burn sagebrush (*Artemesia* spp.) to replace it with native prairie grass and lose Brewer's Sparrows (*Spizella breweri*) and Sage Thrashers (*Oreoscoptes montanus*)?

Apart from ungulates and waterfowl, we know very little about the specifics of individual species requirements on breeding and wintering grounds. Research is underway now on the effects on bird populations of forest fragmentation in north-central Alberta. This work is critical to development of a sound forest management strategy. Conventional wisdom may be misleading as the work of Charles Kay (1990, Chadde and Kay 1991) shows. Kay has looked critically at "the natural regulation" paradigm adopted by Yellowstone National Park officials as management policy for large ungulates. His work shows that this policy will lead to the extinction of the plant communities on which elk depend. Research by one of my students (Lisa Mahon) on Baird's Sparrows (*Ammodramus bairdii*) at the McIntyre Ranch south of Magrath, Alberta provides another argument against conventional wisdom. The McIntyre Ranch is an area of relatively undisturbed northern fescue grassland. It provides superb habitat for Baird's Sparrows. However, a lack of predators has allowed Richardson's Ground Squirrel (*Spermophilus richardsonii*) numbers to explode. An experiment conducted at the site suggests that opportunistic predation by ground squirrels may be a major source of mortality of Baird's Sparrow nestlings. Hence the superficially attractive site would have to be studied carefully before the Baird's Sparrow population on it could be assumed to be stable.

A final area of research I would like to mention is taxonomic—in my case, species boundaries of passerine birds, particularly in Alberta. Recent work, which my colleagues, students, and myself have been involved with, has shown that there are two distinct species of Warbling Vireo (*Vireo gilvus*) and Solitary Vireo (*Vireo solitarius*) in Alberta. The *gilvus* form of the Warbling Vireo is found in central and southeastern Alberta, whereas the *swainsonii* form is a foothills and northern boreal forest bird. The *solitarius* form of the Solitary Vireo breeds in boreal forest, whereas the *cassinii* form is found in the mountains of the southwest and into the interior of British Columbia. The implications of this are twofold. First, to preserve biodiversity, each member of each pair of species has to be considered separately for possible conservation action. Therefore, the extensive aspen stands in the southern boreal forest may be key to the survival of *Vireo gilvus swainsonii* despite an abundance of *gilvus gilvus* in the aspen parkland. The second implication is: how many more species have populations which may in fact be genetically distinct, even separate species? Even with a well-known group of vertebrates, like birds, there could be many more. With groups such as plants or invertebrates, the list would be huge.

It has been clear from recent studies that many new species (or species new to the region) remain to be discovered in Alberta and undoubtedly elsewhere on the prairies. Before we can conserve anything, we have to know what's there. The research required to identify new species is an essential prelude to effective management or long-term preservation of a species or a habitat.

In summary, research of all kinds; summative, applied, and basic (theoretical), are and will be needed as we encounter problems in maintaining currently protected areas, setting environmental goals, evaluating alternative management plans, and dealing with change. To deny a role for research makes as little sense today as it did to Montague Chamberlain in 1887.

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PLANT CONSERVATION IN SASKATCHEWAN AND THE RARE PLANTS DATABASE

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THE STATUS OF PLANT CONSERVATION IN SASKATCHEWAN

Traditionally, the protection of rare and endangered native plants has received far less public interest and attention than has that of endangered faunal wildlife, especially birds and mammals. This is even more true for Saskatchewan and western Canada than for more eastern regions, no doubt due in large part to the fewer field botanists here and perhaps a greater general orientation of regional naturalists towards animal wildlife. A botanical component also appears quite lacking in Saskatchewan government departments concerned with wildlife, parks, and the environment. Historically, native flora studies have been given a low priority in terms of research funding.

But in recent years we have witnessed an ever broadening concern for man's stewardship of his whole biological heritage and the preservation of overall natural biological diversity, including the native flora. There now appears to be a better appreciation of the value of conserving whole natural ecosystems (i.e., saving and protecting representative and unique natural areas, with their full species spectra, including the rarest plants and animals in their natural habitats).

It is not sufficient to consider plants as only "habitat" for other "more important" wildlife. Such a narrow view almost invariably ignores the total floristic diversity of natural ecosystems. For instance, overgrazed rangelands, seriously depleted of original species diversity, but "rejuvenated" perhaps to the extent of producing a fair growth of a few food-grasses (native or even exotic), may be considered by some "wildlife" biologists to constitute sufficient "habitat" for particular animal wildlife species, despite its floristically unnatural state. (Perhaps, with tongue-in-cheek, I might suggest that this view is exemplified on page 6 of the Prairie Conservation Action Plan [PCAP], World Wildlife Fund [WWF] 1988), where the textual exhortation that native species need to be conserved in their natural ecosystems, is accompanied by an illustration of a Black-footed Ferret [*Mustela nigripes*] surrounded by its "natural" habitat of exotic Crested Wheat Grass [*Agropyron cristatum*] and Quack Grass [*A. repens*]). But our native flora represents far more than just "habitat." In its total diversity, including the rarest species, it is itself an integral and important component of our total wildlife natural heritage, fully deserving preservation in its own right.

We should never make the error of unequivocally equating "uncultivated" lands to "natural ecosystems," as indeed did the 1988 PCAP and the accompanying WWF map of "Native Prairie in the Habitat Subregions of Prairie Canada." From a botanical point of view, I am convinced that we are actually much worse off in terms of lost natural ecosystem biodiversity, than such "statistics" tend to indicate. It is an unacceptable conjectural "long-jump," to equate unploughed, although often seriously overgrazed and floristically depleted rangelands, to natural prairie ecosystems. In fact, next to the "plough" has been the "cow," in terms of serious agricultural impacts on native prairie plant communities. The natural flora and fauna of never cultivated river and stream valleys may also have been greatly altered by dam-building (with both downstream and upstream effects), water-diversions, channelling, and herbicide runoffs. The latter has also negatively affected many "natural" sloughs, shrublands, and aspen groves. With major and extensive depletions of original ecosystem biodiversity, the rarer species most likely are irretrievably lost. The presumption that disturbed environments are "renewable" through natural successional processes, seems a much over-used and overly optimistic concept (rationale?). Achievement of anything even close to full restorations of the natural species spectra of original flora and fauna, is highly improbable following any serious and extensive disruptions of native ecosystems, whether these are the result of land-cultivation, overpasturing, or forest-clearcutting. It is critical that we preserve significant portions of the few remaining, relatively pristine, native ecosystems before it is too late.

THE SASKATCHEWAN RARE PLANTS DATABASE PROJECT

Although lagging behind research on rare and endangered mammals and birds, work has steadily progressed during the last two decades on delimiting, listing, and recording information about the rarer native plants of Saskatchewan. Historically, in response to an increasing number of inquiries during the 1970s from the interested public, various persons formulated "preliminary lists" of Saskatchewan's rare plants. These earlier, mostly deficient compilations were superseded in 1979 by the publication of the National Museum's Syllogeus No. 20 - "The Rare Vascular Plants of Saskatchewan" (Maher et al. 1979). Subsequently this latter publication has served as the basic reference source on Saskatchewan's rare native vascular plants and their provincial distributions. But after 13 years, this 1979 annotated list of Saskatchewan rare plants is out of date, and was admittedly cursory and tentative from the first. Some included taxa no longer seem to deserve a rarity status because of the additional records now known for them, and others are questionable; a few seem best taxonomically merged under larger groups, while some previously unrecognized rare segregants, appear deserving of separate taxonomic status; and, since 1979, about a score of additional species, mostly deserving a rare status, have been added to the known native flora of the province.

The compilation of actual collection-label data for the locality records, not included by Maher et al. (1979), seemed an important and necessary first step in having enough available information for meaningful evaluations of rarity status and for valid phytogeographical, ecological, and historical interpretations. In response to this need, the "Saskatchewan Rare Plants Database Project" (centred at the Fraser Herbarium, University of Saskatchewan, Saskatoon) was initiated in 1990 and has represented a relatively major information-gathering endeavour, supported by the Saskatchewan Natural History Society and the University of Saskatchewan. The project is basically an attempt to produce a computer-assisted inventory of the collection data and literature reports of Saskatchewan's putatively rare native vascular plants, including their geographical locations, habitats, and population sizes, as well as collection dates, collectors, collection numbers, herbaria where the record-documenting specimens are filed with their accession numbers, indications of identity verifications, and literature references. The candidate list of provincially rare plants included all 300 taxa that were in Maher et al. (1979), plus 175 additional ones, for a total of 475 taxa. The collections from this province of the candidate rare taxa were personally verified and their collection label data recorded, mainly during visitations, thus far, of eight herbaria with sizable holdings of Saskatchewan plants.

The Database "A" includes the recorded localities for each species from herbarium collection labels and literature reports, along with other given data. Although perhaps rearranged to fit the 10 systematized data-fields, the transcribed information, for the most part, is precisely that given by the original collector. Whether deemed ample or not, the collector's original label data usually represent the primary or only information available concerning local populations of these species and thus the starting point for the accumulation of more knowledge. The geographical information and coordinates are those given on the original collection labels, with the latitude/longitude coordinates deduced by us being parenthetically included. The recording of actual collection label information and literature reports into the Database "A," which has represented the major and most time-consuming phase of the project, has now been brought essentially up-to-date, (although never completed, but needing continual input of new information). This primary Database "A" has become quite sizable, including a present total of over 8000 collection records, averaging about three duplicate specimens apiece filed in different herbaria. The printouts fill 50 three-ring note-binders.

The second phase of our Saskatchewan Rare Plants Database Project has involved the production of taxon summary sheets, including general information on names, synonyms, herbarium and reference sources of records, general ranges, habitats, previous rarity designations, and assessments of the various facets of each taxon's rarity status in Saskatchewan, such as the number of known localities, distributions of these (regional restrictions), sizes of local populations, etc. This attempted (re)assessment of the provincial rarity status of each candidate taxon has represented our major challenge.

Although for immediate purposes, including the taxon rarity assessments, Saskatchewan distribution maps were hand-prepared for the rare plant candidates, we are instituting a computer Geographic Information System to eventually allow direct transfers of the computerized database information to provincial maps, better permitting various map manipulations and information recoveries for individual and combinations of species as related to geographical areas.

Ultimate goals of the overall Saskatchewan Rare Plants Database project include the production of individual rare taxon summary sheets, an updated list of the provincially rare plants in Saskatchewan with an assessment of their rarity status, and a priority-categorized list. Our database of herbarium specimen data and literature reports is only a first step in compiling knowledge about our provincial rarities. Almost all rare species require further field and laboratory studies, followed by efforts to conserve them in their natural habitats. The nationally rare species represent immediate candidates for the production of detailed, full-fledged, COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status reports on their rarity status.

With the available information on our rare species continually increasing, their rarity status remains in a dynamic state, needing continuous reevaluation. Any new locality and collection data on Saskatchewan rare plants should be forwarded to the Fraser Herbarium, University of Saskatchewan, Saskatoon, for verification and entry into the Saskatchewan Rare Plants Database.

ACKNOWLEDGMENTS

We gratefully acknowledge the financial support of the Saskatchewan Natural History Society, via a grant-in-aid, and the University of Saskatchewan, for the Saskatchewan Rare Plants Database Project. The extraordinary efforts of herbarium and research technicians, Peggy Ann Ryan and Judy Haraldson, in organizing, programming, and data-processing for this project have contributed much to its success.

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MONITORING RARE PLANTS - MORE THAN JUST LOOKING FOR A FOUR-LEAVED CLOVER

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INTRODUCTION

In this paper, we introduce and summarize approaches to rare vascular plant monitoring and then review some of the monitoring projects being done in Alberta.

What is rare plant monitoring? Palmer (1986) defined it as "the acquisition of quantitative data that documents the condition of the population or community over time." First, a population or species of concern is identified—it may be rare, endangered, or even just locally threatened or uncommon. Then, a monitoring program is developed.

TYPES OF RARE PLANT MONITORING

There are three main types of monitoring generally recognized (Palmer 1986): 1) simple count or estimate of individuals (inventory); 2) comprehensive appraisal of part of a population, usually using plots or complete counts (census); and 3) using permanent plots to gather data on growth, mortality, and reproductive capability of individuals (demographic monitoring).

Inventories and censusing can result in an indication of population trends; censusing and demographic monitoring can give insight as to why these trends are occurring. The following discussion looks at each type in more detail.

Inventory

Initially, a population must be inventoried to collect baseline data. The number of individuals is counted or estimated using a repeatable method. This is an important first step in determining the status of the species of concern.

Often, as part of the count, the numbers of seedlings, as well as numbers of flowering, non-flowering, fruiting, and senescent individuals are noted or estimated. Individuals may be grouped according to size and age classes and the numbers in each class noted. It is important to clearly define the classes so that subsequent surveys can yield comparable results. Additional information that should be noted in an inventory type of monitoring program (Henifin et al. 1981) includes the following: the exact location of each population, with clear directions to allow easy relocation; detailed habitat descriptions for each population; the extent of the area that the population covers, noting any areas or microhabitats that appear important to the population; any observations on species biology such as the identity of pollinators or nature of seed dispersal mechanisms; and any evidence of disturbance, impacts, predation, or threats.

Repeating an inventory over a number of years is the simplest form of monitoring. This can indicate the vigor, over time, of a specific population. Such monitoring can also reveal whether the population is stable, increasing or decreasing.

Census

The census type of monitoring is usually more complex than, but can be very similar to, the inventory type. Permanent plots are set up and individuals are counted (or estimated using a repeatable method) within the plots. Depending on study objectives, plots may be set up in different habitat types, or in habitat types that are comparable but under different management regimes. The populations can be counted and compared. The census type of monitoring is useful for determining preferred habitats and those factors limiting the population, or for evaluating effects of different land uses (e.g., grazing, haying, and recreation use).

Demographic Monitoring

Demographic monitoring programs are studies that follow the fate of individual plants. Usually individual stems are marked and/or mapped in a population and followed through the growing season, often for several years. This type of monitoring program is complicated and time-consuming and, therefore, is not appropriate for all species. Demographic monitoring is used mainly for species or populations for which detailed information about life history may be required to ensure survival.

Demographic monitoring gathers information on distribution, ecology, predation, mortality, and reproduction. As with a census program, the population size and numbers of flowering individuals are determined. In addition, the following characteristics may be studied: fruit and seed set, plant height, leaf number, leaf size, stem diameter, seedling number, distribution, predation, and mortality.

A demographic monitoring program can be quite complicated, measuring every population characteristic possible, and making comparisons in several different habitats, or it can be quite simple, measuring only one or two factors. Which factors are important will depend on the species being monitored. Owen and Rosentreter (1992) looked at several of the possible approaches and factors, and discussed some of their advantages and shortcomings.

SETTING UP A RARE PLANT MONITORING PROJECT

The goal of a monitoring program is to "provide data that can be used to maintain, enhance and ensure the survival of the population, the species, or the natural community to which they belong" (Sutter 1986).

For a monitoring program to provide relevant, useful data, it must be carefully tailored to the species being monitored, designed to answer specific questions, and characterized by enough flexibility to allow change. Before a monitoring program is set up, as much information as possible should be compiled from the literature on the species of interest, including: population biology, environmental requirements and preferences, pollinators, parasites, diseases, seed predation, herbivory, demography, community structure, etc. (Baskin and Baskin 1986). One of the objectives of a monitoring project is to try to fill information gaps.

Pickart (1991) suggests six steps to set up a monitoring project: 1) review available information; 2) collect and determine the adequacy of baseline data; 3) identify research needs; 4) establish objectives; 5) determine variables to monitor; and 6) develop field methodology.

This process was designed to ensure that the monitoring program is tailored to the species to be monitored and to assist in the selection of important and appropriate factors to monitor.

IDENTIFYING ALBERTA SPECIES OF CONCERN

Although lists of rare species for Alberta have been available for years (Argus and White 1978, Packer and Bradley 1984), very little information has been available on the status of individual species. Since about 1986, interest groups and government agencies have been working together, first to determine the priority species and their Alberta status, and then to begin to monitor some species.

Defining Priority Species

The first step in identifying priority species was a detailed literature search on each of the 360 species included on the list of rare plants for Alberta (Packer and Bradley 1984). The purpose of this project was to look at the status of each species throughout its range in order to develop priorities for further species studies (Fairbarns et al. 1987, Cottonwood Consultants Ltd. 1987, Wallis et al. 1987a and 1987b). Generally, endemic species were considered highest priority, then disjunct species, then peripheral species. This was the first step in compiling the information required to assess and manage range plants in Alberta. The next phase was to locate and inventory populations of rare species, concentrating on those of highest priority.

A rare plant is defined here as a species with a small population within the province. A threatened plant is a species likely to become endangered in all, or a significant part of, its range in the province, if the factors affecting its vulnerability do not become reversed. An endangered plant is a species in danger of extirpation through all, or a significant portion of, its range in the province.

Of the 58 species that have been reviewed (Cottonwood Consultants Ltd. 1986 and 1988a), six species are considered endangered in Alberta: Onion (*Allium geyeri*), Mountain Lady's-slipper (*Cypripedium montanum*), Yellow Indian Paint-brush (*Castilleja cusickii*), Sand Nut-grass (*Cyperus schweinitzii*), Blue Flag (*Iris missouriensis*), and Western Spiderwort (*Tradescantia occidentalis*).

The following six species were determined to be threatened in Alberta: Sand Verbena (*Abronia micrantha*), Low Milk Vetch (*Astragalus lotiflorus*), Nebraska Sedge (*Carex nebraskensis*), Goosefoot (*Chenopodium subglabrum*), Annual Skeleton-weed (*Lygodesmia rostrata*), and Clammyweed (*Polanisia dodecandra*).

Eight species were recommended for deletion from the rare species list, and the remaining 38 species were determined to be rare in Alberta.

The gathering of detailed background information has been initiated or completed for some of the endangered species (e.g., Wilkinson 1987).

When faced with almost one-quarter of the provincial flora being listed as "rare," it is difficult to know where to start to monitor and protect species and habitats. Using a process of sifting through the full list of rare species to identify priority species and then determining the status of priority species, the task has been made much simpler.

Since 1986, when priority species were initially identified, the Rare Vascular Plants in Canada (Argus and Pryor 1990) has been published. This document ranks species on a national level, thereby providing further information for identifying priority species to monitor.

MONITORING PROJECTS IN ALBERTA

Three examples of monitoring projects are presented here: the endangered Blue Flag; a single population of Yellow Indian Paint-brush, which is also considered endangered; and two rare species, Smooth Boisduvalia (*Boisduvalia glabella*) and Upland Evening Primrose (*Oenothera andina*). Although these are also priority species, a main focus of the last two monitoring projects is to examine the effects of grazing management strategies on these rare species, and to guide changes in management practices as required.

Western Blue Flag Monitoring in Southwestern Alberta

Because this species was found to be endangered in Alberta and occurs nowhere else in Canada, Western Blue Flag clearly has a high priority for conservation in Alberta. Argus and Pryor (1990) gave Western Blue Flag their highest priority rating (priority 1).

A census of known Blue Flag populations was undertaken in 1987 and permanent monitoring plots set up. The objective of this monitoring project is to track the status of this endangered species and to determine population trends (Cottonwood Consultants 1988b).

Plots were set up to sample a cross section of populations in slightly different topographic positions, populations under different grazing regimes, and populations in the main concentration areas. By placing plots in a variety of habitats and management regimes, information on the preferred habitat and on effects of management is being gathered. Six plots (2.5 m x 2.5 m) were set up to include the maximum number of individuals. Corners were permanently marked with metal tubing and measurements to other features were taken to aid in plot relocation.

Each plot was overlain by a grid of 100 squares (250 mm by 250 mm), using nails and twine. The Blue Flag stems in each square were counted and recorded as flowering and nonflowering. Each plot was photographed and habitat features, such as shrub growth and topography, were noted. Each site was revisited in August to determine seed set and vegetative changes. The populations need to be inspected yearly and censused every third year (Cottonwood Consultants 1988b).

Yellow Indian Paint-brush Monitoring at Outpost Wetlands Natural Area

The Outpost Wetlands Natural Area was purchased in 1987 by Alberta Forestry, Lands and Wildlife and the Nature Conservancy of Canada. Heavy grazing and conversion to non-native pasture had severely degraded the "naturalness" of the site, but with its diversity and extensive wetlands, the site was still considered a valuable contribution to the protection of Alberta's natural diversity.

The Outpost Wetlands Natural Area is located in southwestern Alberta in a region known as one of the four richest areas for rare plants in Alberta (Cottonwood Consultants Ltd. 1983). Accordingly, eight rare species were documented during the rare plant inventory (Cottonwood Consultants Ltd. 1989a). Of these, one was Yellow Indian Paint-brush, a species that previous inventory studies had determined to be endangered in Alberta (priority 2) and a high priority for protection (Argus and Pryor 1990).

In Alberta, Yellow Indian Paint-brush is peripheral—at the northern limit of its range. Found in moist meadows and grasslands, this species of limited distribution seems to occur only in small populations (Wallis et al. 1987a). Such wet meadows are usually associated with groundwater flow near the surface. This type of habitat is uncommon in Alberta and has been extensively affected by activities such as grazing, cultivation, and introduction of non-native species (Cottonwood Consultants Ltd. 1986).

Cottonwood Consultants Ltd. (1986, 1989a) suggested that the species requires ungrazed or lightly grazed lands, and does not compete well with introduced grasses such as Timothy (*Phleum pratense*) and brome (*Bromus* spp.). Since the purchase of the Natural Area in 1987, the site has been essentially ungrazed. However, even though an absence of grazing should be beneficial to the paintbrush, brome and Timothy appear to be encroaching on the population. If the grazing served to keep these introduced grasses in check, the removal of grazing may prove to be, in fact, harmful to the population in the long-term.

Because of the endangered status of the species and the population in the Natural Area is small, a yearly census type of monitoring project was initiated. The purpose of this project is to document the status of the population over time and to recommend additional monitoring or management, if necessary.

The initial visit to set up the monitoring project was timed to coincide with Yellow Indian Paint-brush flowering, because this would be when individual plants would be easiest to spot. Each Yellow Indian Paint-brush stem was measured and mapped, and general observations made. The number of stems had increased from three, as first noted in the 1989 inventory, to four in 1990.

The researchers took several hours to relocate the population because of the small size of the population and the inconspicuous nature of the species, even though the location of the population was mapped during the initial inventory. To ensure that such delay would not be a problem for subsequent researchers two pins were located and compass bearings determined from prominent landmarks. From the second pin, the compass bearing and distance to the population was determined. This second pin was located within 5 m, far enough to avoid any trampling of the population, but close enough to ensure the population could be relocated.

In 1991, the visit to the Natural Area was scheduled as part of a larger field project. Unfortunately, the timetable had to be set up well in advance. The 1991 season in southwestern Alberta was at least two weeks delayed because of unusually cold weather and greater than normal rainfall. When the Outpost Wetlands Natural Area was visited, the pins were relocated, but the population of Yellow Indian Paint-brush could not be found. Because of the preset schedules, it was not possible to revisit the site in 1991 within the paintbrush flowering season.

Although the inability to relocate the population was somewhat discouraging, it did provide some interesting lessons in plant monitoring. If the monitoring program had been conducted only in 1989 and 1990, we would have concluded that the population was doing relatively well. If the monitoring had been scheduled for every second year, since it was found in 1989 but not in 1991, we might have concluded that the population had been extirpated. Clearly, either conclusion would be premature.

The preceding example reinforces the points that a plant monitoring program must be done over several years, and must remain as flexible as possible to ensure that the populations being monitored are visited at the most appropriate time.

A method of accurately relocating the plant, especially for extremely small populations of inconspicuous species, is essential. Without being confident of searching in almost precisely the right area, the researchers can waste numerous hours (we spent over one hour searching in 1991, even with marker pins and a map) searching for a population that cannot be detected at that specific time.

Where were the paintbrushes in 1991? Were they gone? Were they there, but not distinguishable from the meadow's dense herb and grass? Perhaps they had not yet emerged, because of the cold, wet, and late season. Only by carefully scheduling the 1992 visit will we know.

Milk River Natural Area and Kennedy Coulee Ecological Reserve

At these reserves a census type of monitoring, provides a comprehensive appraisal of part of a plant population in southern Alberta. These protected areas are being managed as a single unit to protect and maintain the ecological and aesthetic character of a representative example of the Mixed Grassland Natural Region, with minimal human interference.

The general management philosophy is to ensure the perpetuation of a variety of representative habitats. The areas have been ungrazed for the past two decades and, thus, offers a good opportunity to study the effects of grazing on the grassland structure in this part of Alberta. The ecological reserve will continue to provide ungrazed conditions and will serve as a control area. In the natural area, the vicinity of dugouts and salt blocks will be heavily grazed, thereby providing habitat for those species that rely on areas of very short grass (e.g., Mountain Plover [*Charadrius montanus*]). The remainder of the uplands will be grazed, initially at a low stocking rate, to provide lightly grazed habitats. A monitoring program, including a component that considers rare vascular plants, was implemented in 1991, before the entry of cattle. The results of the program will be used to guide management strategies for the site and provide advice to grazing managers elsewhere.

Seventeen species of rare vascular plants, as defined by Packer and Bradley (1984), are known from the Milk River Natural Area and Kennedy Coulee Ecological Reserve. Monitoring efforts focus on two species at present—Upland Evening Primrose and Smooth Boisduvalia—both of which are considered to be rare in Canada (Argus and Pryor 1990). These species were chosen because: they have a high Canadian priority (3) for protection (Argus and Pryor 1990); they are thought to be intolerant of heavy grazing (Cottonwood Consultants Ltd. 1989b); and they occur within the area being managed and therefore, may be affected.

Upland Evening Primrose, a member of the evening primrose family, is a small annual that ranges from southern British Columbia, southeastern Alberta, southwestern Saskatchewan, south to California, Utah, and Wyoming (Moss 1983). Its specific habitat requirements comprise somewhat exposed, sandy soils in moist swales or hillsides (Cottonwood Consultants Ltd. 1989b).

In the study area, Upland Evening Primrose has been found in two locations (Cottonwood Consultants Ltd. 1989b), only one of which is the site of census work. Nonetheless, counts were made of the number of individuals found in both populations. A permanent marker pin was placed in the approximate centre of the census population to facilitate finding it in the future. The counting of individuals was carried out when the plants were in flower (i.e., early June). All subsequent counts will be repeated when the plants are at the same stage.

Measurements were completed before the entry of cattle onto the site, so that baseline information was obtained on the size of the population before grazing. We will be doing annual counts of individuals for at least the next three to five years. If we find that the use of cattle is adversely affecting the population, we will alter our management approach, either by lowering the carrying capacity or drawing the cattle away from the site by positioning of fences or salt blocks.

The second species that we looked at, Smooth Boisduvalia, is another member of the evening primrose family. It is also restricted to the southeastern portion of the province, is found on dry mud flats, and is thought to be intolerant of grazing (Cottonwood Consultants Ltd. 1989b). The boisduvalia is found at one location in the study site, along an intermittent stream. The same methodology was followed as for the Upland Evening Primrose, though the counts were carried out in August (when the plants were flowering), and by that time cattle were already on site.

It is too early to draw any conclusions from monitoring efforts at Milk River, because the purpose of this past year's work was to collect baseline data.

Future Monitoring

Plans for future monitoring at Milk River include expanding the program to include other species of rare vascular plants. The same selection criteria will be used as in the preceding cases. These additional species will have a relatively high priority for protection according to Argus and Pryor (1990), will be considered intolerant of grazing, and will occur within the area being grazed by cattle. We may also expand the program to include more detailed demographic work on the populations now being monitored, especially if we find that they are being adversely affected by management practices.

The rare plant monitoring project is only one component of a larger monitoring program that is examining the effect of management on the ecosystem. It is, however, an important component. The results of one part of the monitoring program (e.g., rare plants) will not be viewed in isolation but in conjunction with the other monitoring projects before we adjust any management strategies. Monitoring of rare plants can be an inexpensive program to implement and follow up. At Milk River, we are fortunate to have volunteers who are keen to help out. Clearly, in areas where one is attempting to manage an ecosystem, monitoring of rare plant species should be a component of any monitoring program. After all, plants are wildlife too.

CONCLUSION

If maintaining natural diversity is one of our goals as conservationists or land managers, monitoring of at least the most vulnerable species is needed to ensure that goal is met.

Habitat loss is often the main threat to a species. But, even if the habitat of a species of concern has been secured, this may not always be enough to ensure survival of the species. If there have been changes to an area, or if disturbances or other factors are suspected of causing a decline, monitoring is important to verify population trends. A well-planned monitoring program may also help to understand why the population numbers are changing.

ACKNOWLEDGMENTS

We thank the following for their assistance in these projects: Clare and Kathy Tannas, Eastern Slopes Rangeland Consultants; Cliff Wallis, Cottonwood Consultants Ltd.; Alberta Forestry, Lands and Wildlife: Editorial Services, Natural and Protected Areas Section, Range Management Program - Southern Region, Resource Information Branch; Alberta Recreation and Parks; and World Wildlife Fund Canada

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DEVELOPING A CONSERVATION AND MANAGEMENT STRATEGY FOR RIPARIAN FORESTS IN SOUTHERN ALBERTA

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INTRODUCTION

Riparian forests are the hidden ecosystems of the prairies. Tucked away in river valleys, they are seldom included when we conjure up a vision of prairie. However, many inhabitants of the prairies find their lives enriched immensely by native riparian forests. These prairie ecosystems, although very limited in area, have, and with appropriate care, will continue to sustain a disproportionately large amount of prairie life ecologically, culturally, and spiritually.

Riparian habitats (rivers, streams, and their edges) were specifically recognized in the Prairie Conservation Action Plan (World Wildlife Fund [WWF] 1988). To quote under Goal 3: "...native prairie reserves should be connected by habitat corridors such as riparian habitats.... Riparian habitats are extremely productive systems. Due to water and land management practices, they have become some of the most threatened ecosystems in arid and semi-arid regions of the world.... Action: Within the next five years, habitat management plans for riparian ecosystems should be developed."

In the spring of 1990, Prairie for Tomorrow (a joint program of WWF and the Alberta Fish and Wildlife [AFW] Division) initiated development of a strategy for conserving and managing riparian poplars in southern Alberta. "Riparian poplars" translates into "riparian forests" throughout the central and western Great Plains of North America, since poplars, or "cottonwoods," are by far the predominate native tree species. Western Environmental and Social Trends (WEST) (1991) was contracted to conduct the consultations.

PROCESS

In the environmental management projects it undertakes, WEST applies two fundamental principles. The first principle is that decisions about environmental management must be based on the best available information—information which is current and factual. The second is that all points of view need to be examined in a neutral atmosphere and opportunities provided for achieving consensus and resolving any disputes through open discussion.

To help develop the strategy, an Advisory Group was established with representatives from Alberta Cattle Commission, Alberta Environment, AFW, Federation of Alberta Naturalists, Regional Coordination Services of Alberta Forestry, Lands and Wildlife, the Water Resources Commission, and WWF Canada. The Advisory Group was responsible for providing advice on the consultation process and reviewing and commenting on information materials developed.

Strategy Development has Occurred in Four Steps

Step One: Biology and Status Report

A study was carried out during June to December 1990 to determine the present distribution and density of poplars along rivers in southern Alberta and to assess changes in distribution and density using aerial photography and historical maps. As well, a review of studies relevant to the conservation biology of riparian poplars was undertaken. To ensure accuracy and completeness of the review, a draft was circulated for comment to several knowledgeable scientists. The revised report, *"The Biology and Status of Riparian Poplars in Southern Alberta"* was published in February, 1991 and about 200 copies distributed. It provides managers of riparian habitats and other interested individuals with an information base to assist in decisions about conserving and managing riparian poplars.

Step Two: Interviews with Stakeholders

The second step in developing a strategy was to determine the scope of conservation and management issues and the options available for dealing with these. As a means of ensuring input from those individuals who have an interest and a role to play in the management of riparian forests, interviews were conducted with 46 key stakeholders during April through June 1991. Interviewees included resource planners, water managers, public lands managers, wildlife specialists, natives, irrigation water users, conservationists, canoeists, researchers, and ranchers. Results of the interviews are summarized in a report "*Results of Interviews with Key Stakeholders*" published in August 1991. This report was provided to all interviewees, to the Assistant Deputy Ministers of appropriate agencies, and to members of the Prairie Conservation Coordinating Committee (PCCC). The PCCC is a 50 member multi-stakeholder committee charged with implementing the Prairie Conservation Action Plan in Alberta.

Step Three: Draft Strategy and Strategy Workshop

A workshop to discuss and recommend a strategy for conserving and managing riparian poplar forests was held in conjunction with a meeting of the PCCC on January 28, 1992. Forty individuals from a broad range of government and nongovernment stakeholder organizations participated in the workshop. Discussion at the workshop focused on a draft strategy that had been developed based on the Biology and Status Report and the Stakeholder Interviews and on further information collected, including an assessment of ownership of lands supporting riparian forests.

Step Four: Recommended Strategy

The Recommended Strategy is based on the findings, conclusions, and recommendations of the Biology and Status Report, the Stakeholder Interviews, and the Strategy Workshop. It encourages a pro-active plan of action for conserving and managing riparian poplar forests which will involve not only government agencies, but also organizations and individuals outside of government. The Recommended Strategy will be provided to all workshop participants and presented to the PCCC, the Water Resources Commission, and the Assistant Deputy Ministers of Natural Resource Agencies for their review and hopefully endorsement.

DISTRIBUTION AND STATUS

Riparian forests are found along about 1500 km of river in southern Alberta. They occupy about 700 km^2, or less than 1% of the grassland region. Of the 2075 km of river valley in southern Alberta 9% supports very dense stands of trees, 15% supports dense stands, 22% supports moderate stands, 30% supports sparse stands, and 23% has no forests.

River reaches supporting moderate to dense stands have broad floodplains (greater than 500 m) and channels which are freely meandering or braided.

Distribution and density of mature forests appears to have changed little since the 1950s, based on a comparison of 1980s air photos with those for the 1950s. Slight increases have occurred along three 50 km reaches on the South Saskatchewan, Red Deer, and Bow Rivers.

Significant declines have occurred along the St. Mary and Waterton Rivers below dams, and along a 10 km reach of the Milk River due to fire. As well, recent studies on the Red Deer, Oldman, and Willow Creek suggest that regeneration and survival of young poplars is not adequate to replace, in areal extent, the mature canopy. Lack of regeneration and decline in mature forests also have been documented along rivers in Montana, North Dakota, Wyoming, Colorado, Arizona, and California (Bradley et al. 1991). Factors identified as contributing to lack of regeneration and survival are: altered flows and sedimentation processes due to dams and diversions, livestock grazing, floodplain developments, herbicide use, fire, Beaver (*Castor canadensis*), and prolonged climatic drought (1930s).

Ownership of riparian forests in southern Alberta is as follows: private - 47.7%, provincial (excluding parks) - 21.8%, Indian reserve - 17.6%, town/city - 4.3%, unknown - 3.7%, park/natural area - 2.8%, federal - 1.6%, and municipal district/county - 0.4%.

BENEFITS OF RIPARIAN FORESTS

Benefits and Values of Riparian Forests Identified by Interviewees

Recreation

For many southern Albertans, riparian forests are preferred above any other prairie environment for outdoor recreation activities including picnicking, hiking, bicycling, and camping, and they contribute immeasurably to water related activities such as fishing and canoeing. Seven provincial parks as well as major urban parks and trail systems and several parks in smaller centres are located in riparian forests. These forests also are the sites of several provincial recreation areas and roadside picnic points. Popular boating trips are on reaches bordered by poplar forests.

Wildlife Habitat

Wildlife surveys have found deer concentrate in southern Alberta riparian forests during breeding season and critical winter periods with densities of about 12 per square kilometre recorded in one winter survey, far exceeding those of any other prairie habitat. As well a study in poplar forests of Dinosaur Provincial Park found that breeding bird densities are among the highest in Canada (550 to 706 pairs per 40 ha) and that about 70% of the bird species on the prairies use that habitat exclusively (Bradley et al. 1991).

Aesthetics

Poplar forests in river valleys are considered by southern Albertans to be an important part of the prairie landscape. They provide scenic relief and diversity. Even individuals who seldom go into these forests value them for aesthetic reasons.

Livestock Shelter

For livestock producers on river valley lands supporting poplars, these woodlands provide their animals shelter from sun and wind.

Water Quality

Riparian forests can improve aquatic ecosystems by stabilizing banks, contributing organic matter, providing shade and regulating runoff. On the other hand they may take water from the river through evapotranspiration.

Intrinsic, Spiritual, and Cultural

Some southern Albertans derive spiritual value from riparian forests while others recognize intrinsic or existence values. Furthermore, poplars play an important role in some native ceremonies and traditions where they are recognized as having their own spirits. In the past, riparian forests served as winter camps for the Plains Blackfoot. As well, early settlers built their homes in the shelter of poplars. The distribution of these forests was a factor in the location of Indian reserves and other settlements in southern Alberta.

PROBLEMS AND CHALLENGES

Before effective solutions can be devised, problems need to be clearly defined. Experience in Alberta and other jurisdictions shows that loss of riparian forests on the prairies can occur if their requirements are not considered in water and land use planning and management. If the benefits that riparian forests provide are to be assured, Albertans will need to recognize a responsibility for conserving these forests and develop an understanding of how their activities affect them (Bradley et al. 1991).

Key challenges in developing a management strategy for riparian forests are as follows:

1. Information gaps and scientific uncertainty need to be addressed for improved decision-making.

2. Implementing a management strategy for riparian poplars will require that southern Albertans understand the issues and are willing to make the necessary changes.

3. A fuller accounting of costs and benefits is needed when making decisions about water management and floodplain developments that will affect riparian poplars.

4. A comprehensive approach to managing riparian poplars requires that land management and water management decisions be integrated.

5. Areas of riparian poplars with particularly significant ecological, recreational, or cultural values and which are considered threatened need to be addressed as a priority.

RECOMMENDED STRATEGY

The Recommended Strategy is designed to address the challenges identified through the stakeholder interviews. At the multi-stakeholder workshop, participants agreed on a vision, mission, and guiding principles for the strategy.

The vision of Albertans for riparian poplars is that: Native riparian forests will flourish along southern Alberta rivers so that current and future generations of Albertans can enjoy their benefits and appreciate their intrinsic value.

The vision is fundamental to the development of a mission statement. The mission of a strategy for managing riparian poplars in southern Alberta is: To sustain native riparian forests as key components of southern Alberta river ecosystems by managing land, water, and resource use to protect ecological integrity.

The strategy is built on commonly accepted principles. These principles, which reflect beliefs and values, were enunciated in various ways by Albertans during development of the strategy. They are presented here in no particular order of priority:

1. Best available scientific and technical information should form the basis of riparian forest management decisions.

2. There should be public access to accurate and credible information to assist in making informed decisions about the management of riparian forests.

3. Cooperative and consultative approaches to decision-making and action are essential.

4. Full consideration of environmental, social, and economic costs and benefits should be a part of decision-making.

5. Innovation and flexibility in achieving goals and actions is important. The most desirable solutions are those which are not only ecologically sound, but also cost-effective.

The following five goals are designed to address the problems, opportunities, and key challenges identified for the Riparian Poplar Management Strategy. They are based on the agreed upon principles already outlined. In the Strategy Report each goal has been translated into specific objectives and actions, however these will not be presented in detail here.

1. Goal A: Improve awareness and communication about native riparian forests—their benefits, ecology, management issues, and actions needed to perpetuate these benefits. The objectives and actions address development of awareness programs which consider appropriate information, providers of information, delivery infrastructure, and audiences (landholders, resource managers, stakeholders from agricultural, environmental and recreational groups, and the general public).

2. Goal B: Improve water planning and management for the conservation of riparian forests. The objectives and actions address consideration of riparian forests in instream flow needs studies; operating plans for current and proposed dams and diversions; and environmental assessments on proposed water management projects.

3. Goal C: Improve public and private land use planning and management for the conservation of riparian forests. The objectives and actions address recognition of riparian poplars in provincial, municipal, and other land use plans; a pilot project for achieving conservation of an Environmentally Significant Area (ESA); environmental assessments on floodplain developments; and landholder recognition and incentives. (Note: An ESA is a natural area which has been identified as requiring special environmental management in ESA studies conducted for individual counties and municipal districts in southern Alberta.)

4. Goal D: Identify and remedy information gaps regarding native riparian forests, for improved decision-making. The objectives and actions address research on flow and sedimentation needs, grazing effects, beaver effects, reclamation, and values.

5. Goal E: Implement a comprehensive approach to managing riparian ecosystems which integrates land and water management decisions. Objectives and actions address development of an integrated approach or management system for riparian ecosystems and monitoring results.

The strategy has been developed to assist various government and nongovernment organizations in conserving and managing riparian forests in southern Alberta. It's success will depend on individuals and organizations accepting responsibility for actively managing to protect riparian ecosystems and basing their management decisions on the strategy. Copies of the *Strategy for Conserving and Managing Riparian Forests* can be obtained from Alberta Forestry, Lands and Wildlife, Information Centres in Edmonton and Calgary.

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AMPHIBIANS IN MANITOBA

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ABSTRACT

Fifteen indigenous species of amphibians are known to breed in Manitoba. The Leopard Frog (*Rana pipiens*) has been the most commercially valuable. A fall amphibian season was established in 1971 and up to 50,000 kg of Leopard Frogs were shipped out of the province annually in the early 1970s. Leopard Frog populations died out in 1975/1976, with only a few population pockets remaining. No mortality cause was identified and recovery has been slow, especially in what were once the main population centres. Recent global concern for amphibian populations and local field reports of declines in calling frogs have encouraged the establishment of an annual frog monitoring system in the province. There is also support for detailed studies on amphibian species and their habitats here.

MANITOBA'S RICHNESS

Manitoba contains 15 known species of native amphibians. Ranges and basic information is contained in Bill Preston's (1982) book Amphibians and Reptiles of Manitoba. The most abundant and widespread species are the Wood Frog (*Rana sylvatica*), Leopard Frog, Boreal Chorus Frog (*Pseudacris triseriata maculata*), and Dakota Toad (*Bufo hemiophrys*). Of most significant economic importance is the Leopard Frog which finds excellent habitat in the large shallow lakes with associated marshes in Manitoba.

COMMERCIAL ACTIVITIES

Manitoba Leopard Frogs were larger (9-12/pound) and more hardy (held live until spring term) than were frogs from other commercially harvested areas. Therefore, the province traditionally dominated a large portion of the North American Leopard Frog marketplace, with suppliers paying local collectors approximately $6/kg; and shipping as much as 50,000 kg of frogs to United States Biological Supply Houses.

Prior to 1971, there was frog harvesting both in the fall and winter. In the fall, after "hardening in," they were caught at night along the shores of Lake Manitoba, by hand, with the aid of miner's lights. In the winter, the frogs were captured near Chatfield in artesian wells with long-handled nets and stored in 45 gallon barrels. In 1971, Manitoba established amphibian and reptile seasons.

The amphibian season ran from August through October and the reptile season (Red-sided Garter Snakes [*Thamnophis sirtalis parietalis*]) initially ran the month of September. Much of the frog picking after 1971 was tied to the snake season, since many of the buyers bought both snakes and frogs and pickers typically hunted both species. Pressures of having to pick a maximum number of frogs within a lesser time frame led frog pickers to disobey the seasonal laws creating hostility amongst themselves since each dealer had a maximum number of snakes and frogs to purchase, and once these quotas were reached, no more frogs or snakes were purchased. Once the buyer's quotas were reached, it was not uncommon for additional frogs to be dumped and considered waste.

THE LEOPARD FROG DIE-OFF

The Leopard Frog die-off began in Europe in the late 1950s, reaching North America by the late 1960s, then spreading south and north. Dr. Ken Stewart, at the University of Manitoba, anticipated the die-offs, monitored populations and did laboratory analysis of sick and dying frogs. He had students working with frog populations in the Delta Marsh while his lab work included monitoring over a dozen possible factors involved in the die-off. The University of Wisconsin in Madison also monitored frog populations and attempted to determine possible causes for die-offs. Neither the Wisconsin or Manitoba study pinpointed the cause of death when it occurred. The typical reason given for death was "red leg," a term used to describe a condition in which blood vessels broke down and body fluids accumulated in the semi-transparent tissues on the underside of the hind legs. This condition is a symptom of tissue breakdown and kidney failure but is not a disease in itself.

Leopard Frogs began dying off in Manitoba in 1975, and by 1976 were virtually gone from major population centres. Windrows of dead and dying frogs were

Table 1. Manitoba's reptile and amphibian harvest; from dealer records.

Year	Frogs (pounds)	Snakes (number)	Salamanders (pounds)
1971	68,348	24,800	no record
1972	109,796	56,465	no record
1973	26,272	68,621	no record
1974	43,868	63,429	no record
1975	12,980	30,370	no record
1976	0	48,142	no record
1977	0	34,745	no record
1978	0	43,667	no record
1979	0	23,220	no record
1980	0	30,000	no record
1981	0	37,409	no record
1982	0	64,992	no record
1983	2,911	43,440	no record
1984	13,058	57,245	no record
1985	30,162	90,080	no record
1986	35,981	71,569	no record
1987	9,079	68,497	no record
1988	2,516	82,268	no record
1989	3,546	no season	90
1990	5,891	no season	no record
1991			no season

Records are minimal as sales go unrecorded annually.

reported on Lake Manitoba shorelines, while piles nearly a metre high were recorded from artesian wells. The die-offs were most complete where frog populations were most dense. Some Leopard Frogs survived in isolated populations (golf courses, stock ponds, islands) but the die-off resulted in no frogs being marketed from Manitoba, 1976 to 1983 (Table 1); despite excellent market conditions.

RECENT EVENTS

Following the population crash in 1975/1976, isolated populations remained and in 1983 they were again commercially harvested. Leopard Frog populations have recovered in some areas but densities are not near their former levels. They have not re-occupied the frog holes and appear to be slowly re-building populations in what were their major Manitoba habitats. A site just west of Winnipeg along the Assiniboine River contained all three color variations of the Leopard Frog (blue, green, and brown spots) in the fall of 1990.

Recent increases in Leopard Frog populations in the United States and Mexico and captive rearing facilities have depressed the frog market. The animal rights movement, and increased computer use in education, have brought about a decrease in the demand for Leopard Frogs. Frog prices were lower in 1990/1991 than they had been in the early 1970s, reducing the value of sales records for population estimates.

CAUSE AND EFFECT OF DIE-OFFS

When searching for a cause, we must look at the available factors. Leopard Frogs died off throughout Europe and North America yet no one disease or parasite has been identified as responsible. That fact makes us consider environmental stress factors which may have been severe enough to allow normally benign factors to suddenly combine to kill off populations throughout entire habitat ranges. Since frogs breath through their skin, they are extremely vulnerable to air or water born pollutant stress. The massive Leopard Frog die-offs that occurred without an identifiable cause should have generated extreme concern for the human environment, since amphibian populations are excellent indicators of our world environment. Amphibian population monitoring is needed across Canada and I commend the organizers of this workshop for including this class of species.

AMPHIBIAN SURVEYS FOR MANITOBA

Millions of dollars are being spent world-wide to study amphibian populations. Most to determine if recent population declines are part of a long-term cycle or the result of global changes. If amphibian declines are resulting from man influenced changes in the environment, then society had better know the factors involved so that changes can be made before the planet becomes unsuitable for human life. The following are a few ways in which data could be easily collected on not only Leopard Frogs, but all frog species in Manitoba.

1. Owl surveys are expected to take place annually in southeast Manitoba. Volunteers stop each ½ km to play owl tapes and record calling owls. This survey could easily include recording frog calls if survey members were provided with frog calling tapes and data sheets. Only four to six species would be recorded at that time of year but population trends could be determined for those species.

2. Road surveys are done for breeding birds throughout much of Manitoba. Frog calls could be recorded at each survey stop when volunteers returned to their starting locations. Only a few species would be calling at that time of year but population trends could be determined for them over time.

3. Several Manitoba naturalists spend much of their time in the field, viewing, recording, photographing, and searching for birds and other wildlife throughout the province. These people could be encouraged to record frog calls, egg masses, and tadpoles, especially if they were provided the appropriate tools to identify the species involved and data forms on which to record the information.

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MONITORING AMPHIBIAN POPULATIONS IN ALBERTA: ARE THEY DECLINING?

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Alberta can be divided into four biotic provinces (prairie, aspen parkland, montane, and boreal), each with its own distinctive suite of amphibian species (ten in all). Few of these are greatly restricted in range, with the exception of two of the montane species, which are range marginals in this province. For the most part, the ranges of the amphibian species coincide with the margins of the biotic provinces which contain their typical habitat. Species diversity decreases from south to north; few species are adapted to the long winters and cool, unpredictable summers of the boreal forest. The most widespread species in the province is the Boreal Chorus Frog (*Pseudacris triseriata maculata*), which ranges through all of the province except in the montane areas. Distributions of the Alberta amphibian species are given in Russell and Bauer (1991).

Little information is available on the status of most of the amphibian species. The Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife has placed the Great Plains Toad (*Bufo cognatus*), the Long-toed Salamander (*Ambystoma macrodactylum*), and the Leopard Frog (*Rana pipiens*) on their Red List (at considerable and immediate risk in the province; designated or to be designated as endangered - Anonymous 1991). The Plains Spadefoot Toad (*Scaphiophus bombifrons*) and the Spotted Frog (*Rana pretiosa*) are on the Blue List (at risk in the province, but not in immediate danger; also suspected to be vulnerable, but too little known to be otherwise classified - Anonymous 1991); while the Dakota Toad (*Bufo hemiophrys*) is on the Yellow List (sensitive, but not at risk in the province; may benefit from special management - Anonymous 1991). This is a large fraction of the amphibian species known to occur in this province, and indicates the necessity of garnering more information on the range and status of Alberta's amphibians.

THE ALBERTA MONITORING PROJECT

History

The Alberta task force on declining amphibian populations first convened at the Calgary Zoo on January 18, 1992, on the initiative of Carolyn Seburn, of the University of Alberta, who had been at the organizational meeting of the International Union for the Conservation of Nature (IUCN) Declining Populations of Amphibians Canadian Working Group in Burlington, Ontario, in October of 1991. This earlier meeting established a Canadian organization to carry out the IUCN's mandate to examine amphibian populations worldwide, in order to determine whether the apparent global decline in recent years was real or only apparent. Representatives of the Calgary Zoo, the University of Calgary, Alberta Education, the Federation of Alberta Naturalists (FAN), and a number of smaller natural history societies, met to discuss the possibility of setting up local monitoring projects in Alberta, and to organize some sort of administrative body to formulate guidelines, administer funding, and collate data. A basic monitoring doctrine was established, and some volunteer regional coordinators (responsible for organizing volunteer groups in particular areas) stepped forth. A pro tem provincial coordinator also volunteered.

Since then, our efforts have concentrated upon establishing a consistent set of field protocols for taking data, and upon recruiting local volunteer monitoring groups. We have been fortunate to have the participation of the FAN, an umbrella group for the province, which has made tapes of frog calls available to interested local groups and has promoted monitoring activities among its constituent organizations. The FAN has also undertaken to manage our funds for us. Alberta Fish and Wildlife (AFW) has recently expressed interest in undertaking population monitoring. We have directly approached a number of organizations in the province, and have received positive responses, so it looks as though we will be able to conduct our surveys on a largely volunteer basis.

Methods

We intend to undertake two types of monitoring in Alberta; low intensity and high intensity. Low intensity monitoring will be carried out by volunteer groups, and will cover a wide variety of habitats (and species) over, ideally, the better part of the province. A methodology for low intensity monitoring of amphibian populations has been written and distributed to some groups, and to AFW. This protocol depends upon the local monitoring group to decide where they should undertake their activities, although it gives some pointers on selecting a site. Actual monitoring will consist of repeated counts of breeding adults, taken over the length of the breeding season. Egg mass counts must be taken at the same time. We do not recommend attempting to count larvae, as they are hard to identify to species. Counts yield simple but quantifiable data; we are satisfied that population trends, if consistent and directional over several years, should be evident from counts.

At present two high intensity monitoring projects are underway, on Northern Leopard Frog populations over the range in Alberta (undertaken by Carolyn Seburn) and on Long-toed Salamander populations in the Banff-Canmore corridor, undertaken by A.P. Russell and Larry Powell. Both of these projects are partially funded by AFW. Both are mark-recapture projects carried out by professionals, concentrating upon the population dynamics of the target species over a period of at least two years, if not more.

At present, our data repository is with Larry Powell at the University of Calgary.

Prospects

We have managed to get several amateur groups interested in establishing local low intensity monitoring projects distributed over much of the southern part of the province. AFW has expressed active interest in undertaking further low intensity monitoring projects with its own personnel. A protocol for taking low intensity data has been promulgated. We have two high intensity monitoring projects in place. While we feel that it would be desirable to have more groups in place this spring, we have not had a great deal of time to prepare this year, and the start that we've made in 1992 bodes well for 1993.

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THE RANGE AND STATUS OF THE EASTERN SHORT-HORNED LIZARD IN THE CANADIAN PRAIRIES

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INTRODUCTION

The geographic range of the Short-horned Lizard (*Phrynosoma douglassi*) covers much of western North America (Smith 1946, Reeve 1952, Sherbrooke 1981). The six recognized subspecies of Short-horned Lizard range from west-central Mexico in the south to southern British Columbia, Alberta, and Saskatchewan in the north (Reeve 1952, Logier and Toner 1961). The Short-horned Lizard is classed as a non-desert species of phrynosome by Heath (1965), and is found in a variety of habitats over its latitudinal range. In the north of its range it is found in sagebrush communities and semi-arid short grass prairie (Smith 1946, Sherbrooke 1981, Powell and Russell 1984, 1991a). The Short-horned Lizard is always found at high altitudes, but its upper altitudinal limit is closer to sea level in the northern part of its range (Montanucci 1981).

Two subspecies of Short-horned Lizard have been recorded from Canada, the Pygmy Short-horned Lizard (*Phrynosoma douglassi douglassi*) in southern British Columbia, and the Eastern Short-horned Lizard (*P. d. brevirostre*) in southeastern Alberta and southwestern Saskatchewan (Smith 1946, Logier and Toner 1961, Cook 1966, 1984). Here we summarize data on the known range, ecology, and abundance of the Eastern Short-horned Lizard in Alberta and Saskatchewan, and make recommendations concerning management and conservation.

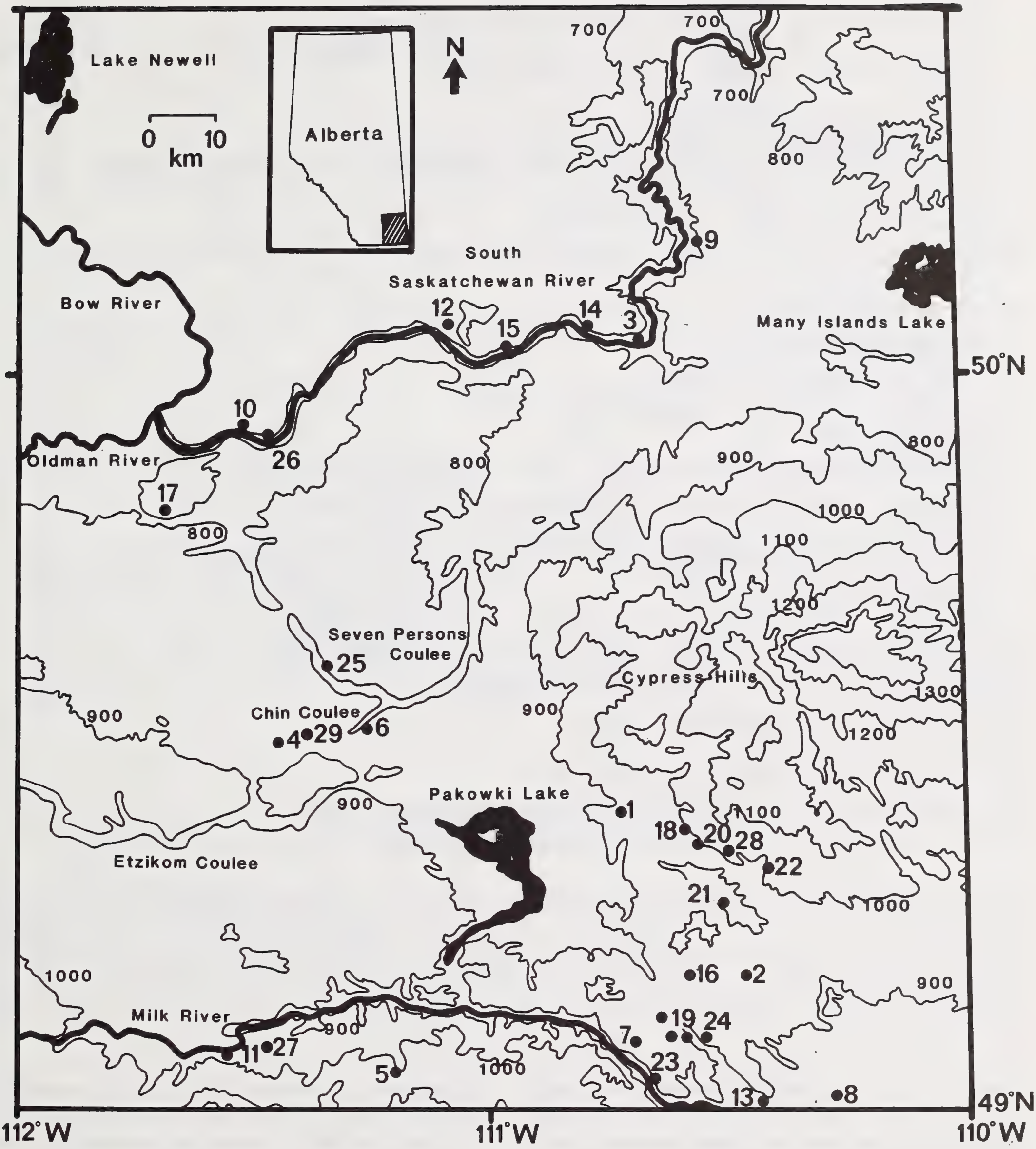
THE RANGE IN THE PRAIRIE PROVINCES

The range of the Eastern Short-horned Lizard is not well-known in Montana, although it is distributed through much of the eastern half of the state; it appears to be contiguous with the known distribution in Saskatchewan, but not with that in Alberta (Thompson 1982).

The range of the Eastern Short-horned Lizard extends north to 50°10′N in Alberta. The distribution appears to be disjunct, one group being found along the South Saskatchewan River, another group distributed through the Milk River and Pakowki Lake drainages (apparently broken into eastern and western subgroups), and the third group at Chin Coulee and 40-Mile Coulee (Figure 1). The South Saskatchewan River valley forms the northern boundary of the recorded range. There are no records east of Wildhorse in this province, and the Cypress Hills limit distribution to the northeast, while to the southwest the Sweetgrass Hills seem to confine populations to the immediate Milk River valley. The maximum elevation at which any population is found is 1035 m, along the southern edge of the Cypress Hills. Most of the rest of the southern populations are found at 900 m. The Chin Coulee populations are found at 800 m, as is the one in 40-Mile Coulee, while those lying along the South Saskatchewan River reside at 700 m.

The soil in the vicinity of Manyberries and Onefour, Alberta, is classified as Bl_5 in the Soils of Canada Inventory (Clayton et al. 1977), a brown solonetz with a loamy texture. The soils of the remainder of the Eastern Short-horned Lizard's range in Alberta are classified as Al_{22} and Al_{23} (Clayton et al. 1977), both brown chernozemic soils that are loamy in texture. These soil types experience temperatures of 25°C or warmer for less than 120 days of the year. The moisture class is subarid, the soils being mainly dry when their temperature is 5°C or higher. This entire area lies within the dry steppe climatic region of Alberta (Longley 1977). The growing season begins around April 15, and the mean date of the last spring frost is between May 15 and June 1 (Ibid.). Summers are hot, the mean July temperature over the range varying between 19°C and 20°C (Ibid.). The average date of the first fall frost is later than September 15 over the range, for an average frost-free period of 120 days (Ibid.). Total annual precipitation over the range averages 33 cm, most of which falls between April and October, with a peak in July. The climate in the summer over the range can best be described as hot and dry.

The climax vegetation in this part of Alberta is the mixed grass prairie association (Coupland 1950, 1961, North 1976, Wallis 1976). Its dominant successional



1. Manyberries (Logier and Toner 1961; Lewin 1963; NMC 1922; NMC 3482; UAMZ 40; UAMZ 97; UAMZ 122 - 126);
2. Onefour (Logier and Toner 1961; UAMZ 41 - 42; UAMZ 277 - 278; UAMZ 280 - 281);
3. Medicine Hat (Logier and Toner 1961; NMC 356; UAMZ 13; UAMZ 131; D. Berisco, pers. comm.);
4. Chin Coulee at Foremost (Williams 1946; Lewin 1963; NMC 1147; NMC 1830; Powell and Russell 1991);
5. Bear Gulch (Williams 1946);

(cont.)

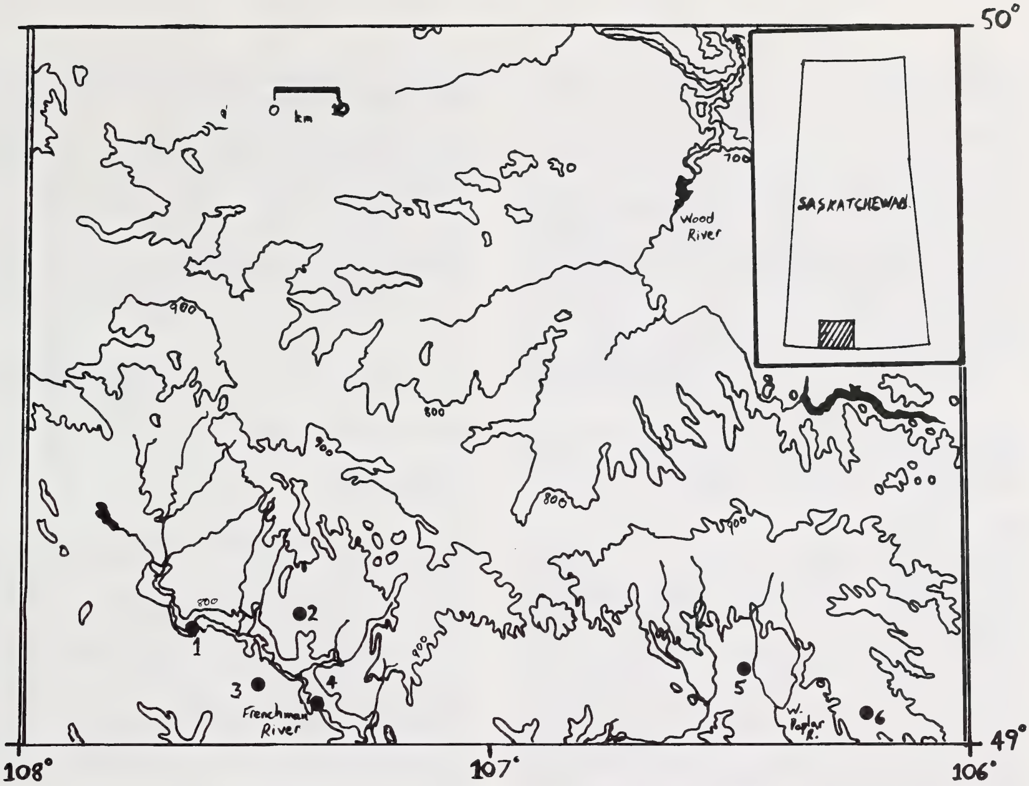
6. Nemiskam National Park (Soper 1949; Powell and Russell 1991);
7. Comrey (Lewin 1963; Powell and Russell 1984; NMC 1857; UAMZ 128; UCMZ(R) 1980.20; UCMZ(R) 1980.21; UCMZ(R) 1980.25; Powell and Russell 1991);
8. Wildhorse (Lewin 1963; UAMZ 276);
9. 16 km NE of Medicine Hat (Schowalter 1979);
10. 9 km NW of the town of Bow Island (Schowalter 1979; Powell and Russell 1984; UCMZ(R) 1980.22; UCMZ(R) 1980.23; Powell and Russell 1991);
11. Audet Ranch (Schowalter 1979; NMC 1829);
12. Rose Ranch, 20 km S of Suffield (Laird and Leech 1980; Powell and Russell 1984; UAMZ 156 - 157);
13. 8 km S of Onefour (Laird and Leech 1980; UAMZ 93; UAMZ 98 - 102);
14. Redcliff (UAMZ 129 - 130);
15. 11 km W of Redcliff (NMC 3479);
16. Lost River Canyon 9 km S of Onefour (NMC 7333);
17. Grassy Lake (NMC 1020);
18. 20 km SE of Manyberries (Strong, pers. comm.; Powell and Russell 1991);
19. Lost River Canyon W of Onefour (Strong, pers. comm.; NMC 1284);
20. 20 km SE of Manyberries (Harder, pers. comm.; Powell and Russell 1991);
21. Nemiskam Community Pasture (Powell and Russell 1984; UCMZ(R) 1980.19; R. Lee, pers. comm.; Powell and Russell 1991);
22. McKinley's Ranch (Powell and Russell 1984; Powell and Russell 1991);
23. North edge of Milk River Canyon (Lewin 1963; Smith 1975; UAMZ 279);
24. Lost River Canyon (Lewin 1963; UAMZ 43; UAMZ 94);
25. 40-Mile Coulee (M. Nelson, pers. comm.);
26. Second Laidlaw (L. Milne, pers. comm.);
27. MacDonald Coulee (Powell and Russell 1991);
28. Lecuyer's Coulee (W. Smith, pers. comm.; Powell and Russell 1991);
29. Chin Coulee 3 km E of Foremost (Powell and Russell 1991).

Figure 1. The distribution of *Phrynosoma douglassi brevirostre* in southeastern Alberta (hatched area of inset map), in relation to elevation and drainage. Elevation in metres. References following each locality document literature reference, specimen number (NMC - Herpetology Section of the Canadian Museum of Nature, UAMZ - University of Alberta Museum of Zoology, UCMZ(R) - University of Calgary Museum of Zoology), anecdotal report (pers. comm.); Powell and Russell 1991 refers to our survey of 1991 rather than to a document.

stage is the *Stipa - Bouteloua* fasciation (Coupland 1950). In the drier area south of the Cypress Hills this is replaced by the *Bouteloua - Stipa* fasciation (Coupland 1950). Eroded areas throughout the range typically feature the *Agropyron - Muhlenbergia* facies, a varied assortment of drought-resistant species (Coupland 1950).

There are relatively few records of the Eastern Short-horned Lizard from Saskatchewan (Secoy 1976) and these sites are disjunct from those in Alberta (Figure 2). Secoy (1976) stated that the distribution is limited to the Frenchman River valley. However, the Killdeer area localities lie in the Poplar River drainage system (Figure 2), which like the Frenchman River is a tributary of the Milk River (and eventually the Missouri). Secoy (1976) suggests that the Eastern Short-horned Lizard may also occur in the area of Big Muddy Creek, well to the east of all recorded Saskatchewan localities.

The range of the subspecies in Saskatchewan appears to be restricted to the northwest by the Cypress Hills, to the northeast and east by Pinto Butte and Wood Mountain, and to the west by the Boundary Hills. The distribution thus extends no further north



1. Frenchman River valley 11 km southeast of Val Marie (Chandler 1965);
2. Gergovia (NMC 1634; Nero 1957; Logier and Toner 1961);
3. Rosefield (NMC 5680);
4. Frenchman River flats (Nero 1957);
5. 8 km west of Killdeer (NMC 15499);
6. Poplar River drainage (NMC files; no specimen).

Figure 2. Known localities of *Phrynosoma douglassi brevirostre* in Saskatchewan (hatched area of inset map). Elevations are in metres. References following each locality document literature reference or specimen number (NMC - Herpetology Section of the Canadian Museum of Nature).

than 49°30′N. The populations in the area of Val Marie and Rosefield lie at approximately 800 m elevation, while those in the Wood Mountain area are found at an elevation of roughly 900 m. Most of the Saskatchewan populations are found in relatively flat, rolling river bottoms. The Frenchman River populations are in an area underlain by the Bearpaw formation, while those in the vicinity of Killdeer live over Ravenscrag bedrock (Richards and Fung 1969, Whitaker and Vonhof 1973). The soil is classed as $A1_{18}$ over most of the range, with some occurrence of $B1_{5}$. These soils have similar characteristics to their counterparts in Alberta (Clayton et al. 1977). The climate is classified as dry steppe (Longley 1977), with short hot summers and 30 to 35 cm of precipitation annually (Richards and Fung 1969). The average frost-free period ranges in length from 80 to 100 days, beginning from June 1 to 10, and ending between September 1 and 10 (Richards and Fung 1969). The vegetation is mainly the *Bouteloua - Stipa* fasciation (Coupland 1950), in other regards being similar to the range in Alberta.

HABITAT

Alberta

In Alberta, the Eastern Short-horned Lizard is generally found on south-facing slopes of the upper reaches of coulee or canyon slopes (Williams 1946, Soper 1949, Lewin 1963, Halladay 1965, Wallis 1976, Milner 1979), and Bearpaw shale outcrops (McCorquedale 1965). Short-horned Lizard habitat in Alberta can be divided into three types, defined partly by geographical distribution and partly by their differences in various biotic and abiotic characteristics (Powell 1982, Powell and Russell 1991a). These habitat types are defined by qualitative rather than quantitative characteristics, and are not exclusive categories.

Milk River Basin

Site numbers 2, 5, 7, 8, 11, 13, 16, 19, 23, 27 (Figure 1) are associated with the immediate Milk River valley and canyon and with its drainage basin and tributaries (i.e., Lost River) to the east. In this area, populations are generally found upon ecotones, particularly coulee and canyon rims mostly on south-facing slopes. There are anecdotal reports of Short-horned Lizards in this region being found in grassland areas, not near any local break or ecotone, and of them being encountered in coulee bottoms (L. Piotrowski, pers. comm. 1979; P. Stern, pers. comm. 1991). Populations in this habitat type are not abundant to the west, where they appear to be restricted to coulees closely associated with the south side of the Milk River. To the east, populations cluster more thickly; it is from this region (eastern Milk River canyon, Lost River canyon, and breaks north of Onefour) that almost all of the reports of wandering Short-horned Lizards in grassland areas come.

Biotically, this area is typical short grass prairie. The terrain is generally rolling, with frequent exposures of bedrock in coulee and canyon edges, and associated clayey badland areas. The topsoil is generally extremely thin in areas where lizards are found, and burnouts (areas where the topsoil has been eroded away to expose the underlying clay) are common around coulee edges. Most exposed substrate is hard-packed.

Bearpaw Habitat

Site numbers 1, 18, 20, 21, 22, 28 (Figure 1) found along the southern edge of the Cypress Hills plateau, on the north and south sides of Manyberries and Sage Creek valleys. They are invariably associated with extensive surficial exposures of Bearpaw shale, which is very friable, and breaks down to form stretches of distinctive dunes. Creeping Juniper (*Juniperus horizontalis*) is the dominant plant on this substrate, forming large mats which serve to anchor the dunes, but total vegetation cover in these juniper dune areas is not greater than 50%. This terrain occurs in broad shallow ravines, coulees, and steep slopes on the southern and western edge of the Cypress Hills plateau. The higher areas between juniper dune terrains are flat or gently sloping, and generally support a typical short grass prairie vegetation. This terrain predominates over the ridge, forming the southern side and much of the north side of the common valley of Manyberries and Sage Creeks, and the southwestern and western edge of Cypress Hills.

Not all such terrains within the bounds of the range in Alberta can be said to support Short-horned Lizard populations; those lying as far north as the lower reaches of Seven Persons Coulee may be at too great an elevation although more extensive searching is necessary before this can be stated with certainty. We have only two reports of them being found far from juniper dune terrain in this area. However, they do use adjacent grasslands. Aspect varies greatly within these terrains, and slopes of all orientations are used by Short-horned Lizards. The dark colour of the substrate absorbs heat and undoubtedly contributes to this flexibility in orientation.

We do not know how far to the east, or to the north, this lizard is found on terrain of this sort, but suspect that there are more in both directions than have been so far enumerated. This set of sites probably represents a contiguous lizard population and thus represent the largest population, and largest concentration of suitable habitat, in Alberta.

North Marginal Habitat

Site numbers 3, 4, 6, 9, 10, 25, 26, 29 (Figure 1) are scattered along Chin and 40-Mile Coulees, and along the South Saskatchewan River. We refer to their habitat as marginal because these populations appear to be restricted to the south facing canyon and coulee edges, and because this is the northern limit of lizard range in Alberta. The surrounding area is generally flat short grass prairie, with relatively little relief. The valleys are generally 1 km wide or more. Short-horned Lizards are usually found along the channel edges which are elaborated into series of spurs and draws, producing slopes of varying grades and aspects. Generally the slopes are vegetated thinly and on their upper third or so. Short-horned Lizards are most often found on this upper third, seldom descending to the bare lower slopes almost never being found upon the flat grasslands at the tops. The elevations of the tops of the channels vary between 875 m and 700 m. Soils on the upper slopes are sandy and friable. Although it is difficult to be sure, populations in habitat of this type appear to be far more widely scattered and rarer than those in the other habitat categories in Alberta.

Saskatchewan

The Eastern Short-horned Lizard is limited to the short grass prairie area of the southwest where it is found in the badlands (Secoy 1976, Chandler 1965) often where there are outcrops of blue shale (Nero 1957). This association of the species with badlands (especially "blue shale" badlands) and the predominance of the Bearpaw formation through this area (Whitaker and Vonhof 1973) suggests that the species in Saskatchewan is largely restricted to habitat very much like the Bearpaw habitat classification in Alberta. The requisite bedrock is not found in the area occupied by the populations in the Killdeer area (Whitaker and Vonhof 1973), but we have fewer reports from this area.

GENERAL BIOLOGY

Courtship and mating in Short-horned Lizards are described by Montanucci and Baur (1982). Reproduction is described by Goldberg (1971), Guyer (1978), and Guyer and Linder (1985). Clutch size ranged from six to thirteen young in Alberta (University of Alberta Museum of Zoology specimen number 131) (Laird and Leech 1980, Powell and Russell 1991b). Neonates averaged about 24 mm in snout-vent length (SVL), and weighed an average of 0.7 g (Powell and Russell 1991b). Sex ratios varied between clutches, but overall was approximately 50:50 (Powell and Russell 1991b). Parturition occurs from the last week of July to the first week of August, and seems to be synchronized—no gravid females were found in any of the Alberta populations examined after the first week of August (Powell and Russell 1991b). There are indications that parturition takes place around noon. Survivorship of the young has not yet been assessed. Gravidity evidently imposes a considerable physiological strain on reproducing females, and this may act as a limiting factor, since they must recover lost weight in a limited time period before the onset of hibernation (Powell and Russell 1991b).

Sexual maturity in males is attained in the summer after the first winter dormancy but has not been determined for females (Powell and Russell 1985b). Males attained an average adult SVL of 50 mm and an average adult weight of 10 g while females average adult SVL was 70 mm, and average adult weight approximately 18 g. This disparity in adult size between the sexes was probably related to the species' viviparity (Powell and Russell 1985b). Recapture records suggest that females lived as long as five years (Powell and Russell 1985b), but no such estimate can yet be made for male lifespan.

The earliest activity record for the Eastern Short-horned Lizard in Alberta is April 27 (Laird and Leech 1980), and the latest is September 25 (Powell, pers. obs.). Most activity has ceased by the second week of September. The average active season is thus approximately 150 days long. The mean date of the last spring frost is well after the start of yearly activity, which suggests some ability to resist freezing or at least to avoid freezing conditions. These populations exhibit considerable breadth in active body temperature (Powell and Russell 1985a) and this may be important in extending daily activity periods early in the active season and in permitting activity on cool, overcast days. Most lizards have disappeared by the mean date of the first fall frost, presumably having entered winter dormancy. Yearly activity pattern may be controlled by an endogenous cycle triggered by photoperiod since there appears to be little change in environmental temperature over the period in which the lizards cease to be active (Powell and Russell 1985a). The location and nature of hibernacula used by the Alberta populations are unknown, although Short-horned Lizards have been observed moving off an ecotone and into the adjoining badlands at the end of August (Powell, pers. obs.)

Phrynosomes are specialized ant eaters (Pianka and Parker 1975). The Eastern Short-horned Lizard does feature a high proportion of ants in its diet in Alberta, but also preys heavily on beetles and grasshoppers (Powell and Russell 1984). There is some partitioning of the dietary niche between the two sexes; females, due to their greater size, take larger prey items and also a wider size range of prey than males (Powell and Russell 1984).

POPULATION TRENDS

No appropriate field work to indicate population trends has been conducted in Saskatchewan. Data concerning population size and trends, supporting only the most tentative conclusions, are available for four of the Alberta populations of the Eastern Short-horned Lizard (Powell 1982, Powell and Russell 1992). There are no data on possible size fluctuations in these populations in the intervening eleven years.

A great decrease in number was noted at two of Powell's (1982) localities since the systematic field work of 1979 to 1980. Capture success at the two other localities varied greatly in 1979 to 1980, but appeared to reflect a constant population size (Powell and Russell 1992). Success in capturing lizards at any "new" locales examined in the summer of 1991 is consistent with a general decrease in population sizes, and with the extirpation of some populations (40-Mile Coulee, Medicine Hat) (Powell and Russell 1992). Only one site of the fourteen visited by Powell and Russell (1992) in the summer of 1991 yielded large numbers of Short-horned Lizards. While general capture success is suggestive of diminished population sizes almost everywhere, this is a subjective judgement in the absence of comparable earlier data from all but four populations. Also subjective are several independent observations by long-time residents near some Alberta localities, that the lizards are much less frequently seen in recent years.

Powell and Russell (1985a), as a corollary of their growth models for the Alberta Short-horned Lizard populations, extrapolated a population size distribution, for each sex, to be expected over the active season. These depend strongly upon a reasonably invariant yearly average date of parturition, but observation so far suggests that this is a reasonable assumption (Powell and Russell 1985a, 1991b). Powell and Russell (1992) plotted the SVLs (all females and males [Figure 3]) of 1991 Alberta captures, against the day (since January 1, 1991) of capture, superimposing these upon the projected and observed size distributions for each sex for 1979 (from Powell and Russell 1985a).

Both distributions of 1991 lizard sizes conform well to the modelled sex-specific distributions of Powell and Russell (1985a) (Figure 3). However, few females from the 1991 field season were within the adult size range, and of these, none were as large as the large females captured in 1979; few were within the size range typical of females born the previous year (Figure 3). Males are less easily divided into age classes, due to the early cessation of growth in this sex (Powell and Russell 1985a). However, it is evident that

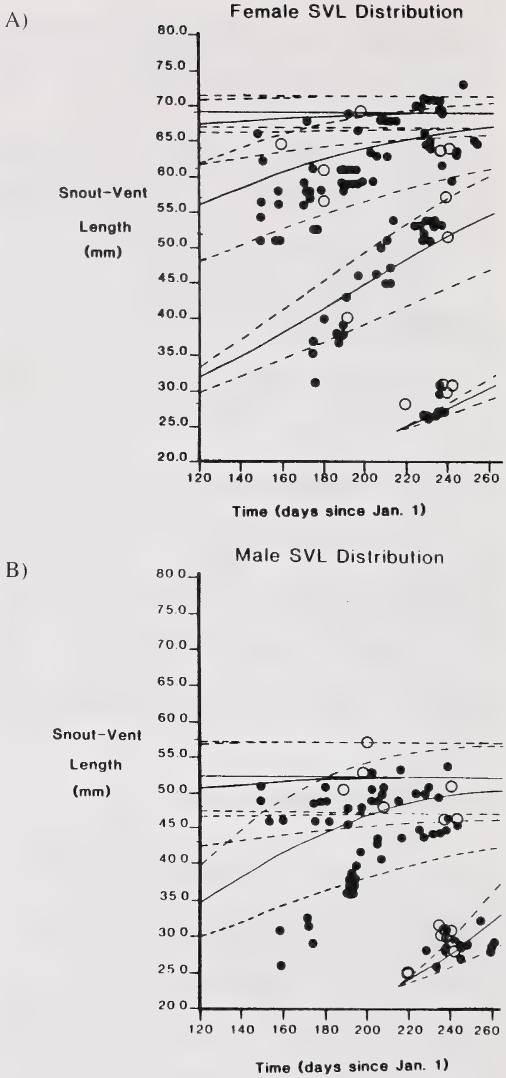


Figure 3. Distribution of snout-vent lengths of all female *Phrynosoma douglassi brevirostre* captured in Alberta in 1979 against day of the year, with superimposed modelled cohort growth patterns and snout-vent length distributions of all female (A) and male (B) Short-horned Lizards captured in Alberta in 1991. Solid circle - observed snout-vent length of 1979 capture; solid line - predicted growth trajectory of one female cohort; dashed lines - upper and lower 95% confidence limits for predicted growth trajectory; open circle - observed snout-vent length of 1991 capture. After Powell and Russell (1992), modified from Powell and Russell (1985a).

almost all males captured in 1991 were of adult size, except for the neonates born that year, a distribution quite different from that displayed by the 1979 captures (Figure 3). There are too few points to allow any firm statements, but both distributions show a marked lack of lizards which were of a size to have been born in the previous year, and in the case of females, of very old individuals (Figure 3). This is consistent with a bottleneck in population sizes over the geographic range examined by us.

The low rate of capture in 1991, the observations of knowledgable locals, and the pooled lizard size distributions, all independently suggest that Short-horned Lizard population sizes have declined throughout the range in Alberta since Powell (1982) did his field work (Powell and Russell 1992). From what information we have available, it is impossible to say whether this is a long-term trend dating from the last organized field work, or a relatively new product of forces operating over the past two or three years. The prolonged drought that the province has sustained suggests itself as an immediate cause. Population decrease has occurred in localities, such as Comrey and Nemiskam Community Pastures, where little or no human activity has taken place over the last eleven years, as well as in localities such as Bow Island where human agencies could conceivably have been at work. Drought, through its depression of productivity and hence insect populations, could act to lessen Short-horned Lizard fecundity and so produce a cumulative decrease in population size over the range (Powell and Russell 1992).

The status of the Saskatchewan populations remains nebulous. Almost all of these localities are represented by single specimens (Nero 1957, Chandler 1965, Secoy 1976), which is suggestive of rarity, but this was true of the Alberta populations until Powell (1982) looked systematically at some of these locales and found that the species was more common than had been previously thought. Nero's (1957) correspondent noted that the species was relatively abundant in the Rosefield area, but that was in 1957.

HUMAN IMPACTS

Once again, we have a much better understanding of human impacts in Alberta than in Saskatchewan. In Alberta they can be broken down into four major categories, which are of varying importance in different parts of the range in this province.

Grazing

Grazing is the primary large-scale human-fostered activity in the southeast quarter of Figure 1, and predominates over much of the rest of the area in which Short-horned Lizard populations are found; in fact, they are not likely to persist in localities where this is not true. Grazing is at worst a neutral activity as far as Short-horned Lizard populations are concerned. Direct effects on individual lizards would extend no further than the small and avoidable chance of getting stepped on by a cow. Grazing intensity will affect the composition of the vegetation in a particular spot. However, unless there are enough cattle on a particular plot of land to reduce it to a dustbowl, this sort of indirect effect is most likely to favour Short-horned Lizards than otherwise. Pygmy Short-horned Lizard, in sagebrush-dominated range in Idaho, maintained larger populations upon grazed rather than ungrazed areas, apparently responding positively to the removal of ground cover (Reynolds 1979). Short-horned Lizards in Canada are likely to do the same. In any case, they are largely found in areas (such as juniper dune terrain and coulee edges) where cattle tend not to congregate. The only deleterious aspects of cattle grazing (which after all does not differ greatly from bison grazing, a probable factor in the evolution of this species) is range improvement by the planting of such forage as Crested Wheat Grass (*Agropyron cristatum*), an activity which few ranchers seem to undertake; and mechanical damage to coulee rims by large numbers of cattle on their way to water. Cattle-related improvements, such as devoting coulee bottoms to haying, or excavating dugouts, do not directly affect Short-horned Lizard habitat, as far as we can tell.

Cultivation

This is a secondary human use of the area over which Short-horned Lizards are found in Alberta, although it predominates in the irrigated district between the South Saskatchewan River and Chin Coulee. Cultivation is uncommon in the area south of the Cypress Hills and Milk River.

Land which is liable to cultivation is not likely to be Short-horned Lizard habitat, as they seldom make much use of either coulee bottoms or flat terrain with no exposed bedrock. The extent to which they are affected by agriculture depends upon the extent to which the farmer uses his marginal land. The Chin Coulee population immediately northeast of Foremost

(Figure 1, Number 29) lives on upper coulee slopes below cultivated land, but persists along much of the coulee's length, likely because cultivation does not approach the edge very closely. The 40-Mile Coulee population (Figure 1, Number 25) may have diminished because cultivation on the east side of the coulee comes very close to the coulee edge below the dam. Populations in South Saskatchewan River valley habitat in Alberta, which are found in the main stretch of cultivated land between Foremost and the South Saskatchewan River, appear to be restricted to the upper reaches of coulee or canyon slopes. Circumscribing these closely with cultivated land will allow agricultural chemicals to readily drain off into Short-horned Lizard habitat, and will reduce the prairie "hinterland" at the top, which the upper slopes may draw upon as a biotic reservoir, even though Short-horned Lizards do not appear to use this topside terrain directly. These constraints will mainly affect populations to be found along Chin and 40-Mile Coulees, plus any which may exist along Seven Persons Coulee.

Irrigation works themselves may have impacts upon adjacent populations, although this is difficult to demonstrate directly. It is interesting that the only recent large-scale irrigation work within the Alberta range, the new dam and reservoir in 40-Mile Coulee, is the site of one of the few recorded Short-horned Lizard populations which Powell and Russell (1992) concluded was extinct. If Short-horned Lizards were found on the slopes above where the reservoir now lies, they may have been adversely affected by the flooding of the lower slopes, or possibly the hibernaculum used by this population was flooded. More work is required to establish the connection, if any, here.

Agriculture is not likely to greatly affect existing populations unless its extent is greatly increased, and unless marginal terrain is consistently ploughed.

Oil and Gas Exploration

The presence of buried gas lines has been noted at some Alberta localities. These do not appear to have a great effect on Short-horned Lizard populations, although their installation has undoubtedly resulted in some disruption.

The major impact of the oil industry is through exploration and extraction. Populations confined to the immediate neighbourhood of riverside bluffs or coulee edges would not be greatly affected by these activities, as they are in fairly inaccessible terrain. Oil-related development has two main effects in the juniper dune habitat lining the Manyberries Creek/Sage Creek valley. Vehicular tracks disturb the terrain, and pose a traffic hazard to Short-horned Lizards, which will tend to disperse through grassy areas via these tracks. The tracks also provide vehicular access for other vehicles. Drilling rigs are installed in the middle of perhaps unnecessarily large bare platforms, which are not reclaimed, whether the hole is a dry one or a pumpjack is installed. This elimination of the natural vegetation, on tracks and on rig platforms, destroys habitat which lizards would otherwise use, and opens the friable Bearpaw substrate to wind and water erosion to an even greater extent than usual. This terrain is delicate, its structure being maintained to a large extent by the slow growing juniper mats, and it is difficult for vegetation to colonize even in its relatively stabilized form.

The effects of this disturbance are not easy to assess, because we have no data on population sizes in the affected areas before the greater part of the development was put in. Short-horned Lizards are evidently persisting in the developed area, but appear to have declined in number in the area of the greatest development, around Manyberries Hills. Some effort at reclamation is needed, but none has been made, except on the most recent well (1990) drilled in this area.

Urbanization

This is of concern to few populations in Alberta. The growth of Medicine Hat north of the South Saskatchewan River has likely caused the recent extirpation of at least one Short-horned Lizard population within the urban area. Unfortunately we cannot tell if there are or were other populations within the Medicine Hat city limits, since none of the records that we have from here are more specific than "Medicine Hat." Urbanization impinges upon Short-horned Lizard populations directly, by destroying habitat, which is frequently very limited in extent to begin with. It also exposes adjacent lizards to hazards of urban life, such as predation by cats and dogs, collection by interested amateurs and small children, and being run over. Populations which are found in untouched and undesirable riverside areas close to towns, such as, apparently, the Redcliff population, will not be directly affected, but are likely to diminish due to long-term diffuse effects of the sort listed above.

PROTECTION

The Alberta Committee on Rare and Endangered Species (Alberta Forestry, Lands and Wildlife) has determined the status of the Eastern Short-horned Lizard to be "threatened" (C.J. Ward, in litt., February 9, 1979, Roberts 1982). It is protected provincially under the Wildlife Act and associated regulations, and has been accorded a position on the provincial Red List (considered for designation as endangered species in Alberta - Anonymous 1991). Very few of the populations in Alberta lie within protected areas. The Milk River Natural Area encompasses the Comrey population, and any populations which may lie on the south side of the Milk River (Anonymous 1984). Exploration and development of a petrochemical site in the Bearpaw Habitat where Short-horned Lizards are known to occur now requires impact assessment and impact mitigation, but this is a relatively recent imposition. All reptiles and amphibians are protected under the provincial Wildlife Act in Saskatchewan, and the Eastern Short-horned Lizard has no particular status in that province. The western block of the Grasslands National Park harbours the four known Short-horned Lizard populations in the Frenchman River valley (Figure 2) which will be protected by the National Parks Act when the park is incorporated (P. Minton, pers. comm., November 14, 1984). A decision on the COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status (Cook and Muir 1984) of the species in Canada is pending this year; we have recommended that the Alberta and Saskatchewan populations of the Eastern Short-horned Lizard be classed in the COSEWIC vulnerable category (Note - approved by COSEWIC in April 1992). The species has no protection in Montana (D.L. Genter, pers. comm., September 23, 1991), where the only possible contiguous populations to those in Canada are to be found (Thompson 1982).

RECOMMENDATIONS

We strongly recommend that more inventory work be done, in order to establish the true distribution of populations in Alberta and particularly in Saskatchewan. We have visited half of the localities given in Figure 1 (Powell and Russell 1992), but the lengths of Chin Coulee, Etzikom Coulee, 40-Mile Coulee, and Seven Persons Coulee all merit inspection. The range in Saskatchewan is established largely on the basis of anecdotal reports. The Frenchman River valley needs systematic inspection, as does the Poplar River drainage near the United States border, and possibly the Big Muddy Creek valley (Secoy 1976). Until distributions, habitat, and abundances are known for both provinces, a conservation policy cannot be properly formulated.

We would recommend that some long-term monitoring of population trends at selected localities be undertaken. We have already noted that we have almost no data on fluctuations in population size of this species in Alberta. What comparative data we do have suggests that population sizes have shrunk considerably over the past ten years. It could be a cyclic phenomenon which we have happened to catch at two different points. A simple mark-recapture program at selected localities in Alberta (Bow Island, Manyberries Hills or LeCuyer's Coulee, and Comrey) would not yield data suitable for formal population estimates, but repeated over a number of years, would indicate whether or not the populations are declining. The Manyberries Creek/Sage Creek valley populations of Alberta should in particular be monitored in this way, in order to assess the impact of the oilfield development there, since this is very important habitat. This is not to say that a proper, long-term demographic study would be out of place, but a monitoring program of the sort we have outlined is easier to set up and maintain. The true trend in numbers among at least some of these populations must be identified before any decisions regarding management and protection can be made.

Once the species is better known in Saskatchewan, a similar program should be initiated there; given the location of most of the known populations within Grasslands National Park, this would probably best come under the aegis of the National Parks Service.

We recommend that the legal and biological status of the Eastern Short-horned Lizard in Alberta and Saskatchewan be more widely disseminated publicly. The Alberta Ministry of Fish and Wildlife has been distributing posters and illustrated pamphlets documenting species whose statuses are of concern in this province. A similar poster or pamphlet for the Eastern Short-horned Lizard would be of benefit in two ways. It should discourage idle collection and would sensitize landowners, leaseholders, and planners to the habitat requirements of the species. It could also serve as a request for data from the public, asking those who know of populations of this species to respond and inform the authorities. Similar mail-in campaigns are currently in place for Leopard Frogs (*Rana pipiens*) and Western Hognose Snakes (*Heterodon nasicus*) in

Alberta. Recommending campaigns of this sort for Saskatchewan is perhaps premature until we have a better idea of how abundant and widely distributed the species is there, and what kind of pressures it is under.

We recommend that an effort be made to discover the location and nature of at least one hibernaculum used by a population of Short-horned Lizards. We have no clear idea of where they overwinter, and yet it is a critical habitat feature for all reptile species in this climate. This would require a short-term radiotelemetry study of several individuals at one site, in order to follow them when they seek shelter for the winter in early fall. The hibernaculum (or hibernacula—they may den up separately) must be identified for any population if its habitat is going to be properly protected.

Finally, we recommend that the effects of irrigation and agricultural practices on adjacent populations of Short-horned Lizards be examined. We have some tentative indications that these effects exist and are deleterious, but the question must be approached systematically.

ACKNOWLEDGMENTS

For permission to work on their lands in Alberta, and for the various kindnesses that they showed us, we would like to thank the following: Leonard and Mary Jane Piotrowski, Will and Rose McKinley, Phil Flaig, Dick and Janet Rose, the Laidlaw family (both generations), Barry and Belinda Lecuyer, Pat Stern, the Prouds, Ian Mitchell, the Gilchrists, Jack Ross, and the proprietors of the original Nemiskam Community Pastures. Cheryl Pearce, Robin Leech, and Mike Hawrylez are to be thanked for their assistance in the field. We are obliged to Dave Schowalter, Linda Strong, Lawrence Harder, Wayne Smith, Francis Cook of the National Museum of Natural Sciences, and Vic Lewin of the University of Alberta, for sharing their data on lizard distribution with us. We are also obliged to Dianne Secoy, Cliff Wallis, Randy Lee, Bill Hall, David Genter, and Phil Minton, for information on the legal status of Short-horned Lizards in their various jurisdictions. Financial support for this project came in part from each of the following: the Department of Biological Sciences, University of Calgary; Natural Science and Engineering Research Council Operating Grant (A-9745) to A.P. Russell; Alberta Parks, Recreation and Wildlife Foundation grant to A.P. Russell; and the Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife with the assistance of Lorne Fitch. Field work in Alberta was conducted under permit, issued us by the Alberta Department of Lands and Forests. Mr. Lee McNeil of Alberta Parks is to be thanked for summer accommodations in 1991.

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STATUS OF THE PRAIRIE RATTLESNAKE AND THE EASTERN YELLOW-BELLIED RACER IN SASKATCHEWAN

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ABSTRACT

In Saskatchewan, the Prairie Rattlesnake (*Crotalus v. viridis*) and the Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*) are considered threatened species of wildlife for which there is no open hunting season. Both species have small, restricted distributions and use communal hibernacula. In 1988 and 1990 to 1991 we conducted surveys for hibernacula and initiated mark-recapture studies on these species in order to better delineate their distributions, document life-history parameters and population demography, and identify existing and potential factors which threaten the existence of these species.

We located 22 Prairie Rattlesnake hibernacula, 12 along the South Saskatchewan River west of Leader and 10 in the Frenchman River Valley east of Val Marie. We estimated a total population of Prairie Rattlesnakes in the province of between 2000 and 4500 individuals. The Prairie Rattlesnake is slow growing and females produce their first litter at about five years of age. The average litter contains eight to 10 young and females probably follow biennial or triennial reproductive cycles. Adult snakes make up the bulk of the population present at dens, presumably neonate and juvenile survivorship is poor.

Twenty-three Eastern Yellow-bellied Racers were captured at nine of the 10 hibernacula in the Frenchman River Valley. Racers are more common than was previously suspected, occurring in low densities throughout the valley. Too few captures were made to be able to say much about life-history parameters, except that the presence of neonates and juveniles among the racers captured suggests that populations are managing to sustain themselves.

Most of the communal hibernacula in Saskatchewan are located on Crown land used for grazing or are within the proposed boundaries of Grasslands National Park. There have been several documented acts of malicious killing of Prairie Rattlesnakes and damage done to dens in the recent past. These are isolated events and confined to well-known dens that have easy vehicle access. The majority of hibernacula are located in remote, uninhabited areas and have received little or no human disturbance. The effects that grazing and farming have on rattlesnakes is largely unknown, but is probably minimal at this time. Recommendations for the management and conservation of these species are discussed.

INTRODUCTION

Relatively little is known concerning the distribution, abundance, and natural history of the twelve reptile and seven amphibian species that occur in Saskatchewan. A few species are considered common over much of the south-central regions in the province (e.g., the Common Garter Snake [*Thamnophis sirtalis*], the Northern Chorus Frog [*Pseudacris triseriata maculata*], the Leopard Frog [*Rana pipiens*]). Most species, however, appear to have restricted or poorly delineated distributions in southern Saskatchewan and are uncommon within their known ranges (e.g., the Prairie Rattlesnake, the Short-horned Lizard [*Phrynosoma douglassi*], the Eastern Yellow-bellied Racer and the Western Hognose Snake *[Heterodon nasicus*]; Cook 1978).

Low population densities and patchy distributions within poorly delineated ranges make field investigations of Canadian herpetofauna challenging. For most species in Saskatchewan, field surveys have not been undertaken to ascertain whether populations have been declining, maintaining themselves, or are expanding. In recent years, however, much has been learned about the Prairie Rattlesnake and other prairie snake species using communal hibernacula (Gannon 1980, Gannon and Secoy 1984, Mackay 1987, Macartney and Weichel 1989).

The Prairie Rattlesnake has a disjunct distribution in Saskatchewan. There is a small southern population along the Frenchman River Valley southeast of Val Marie and a small northern population confined to a 50 km stretch of the South Saskatchewan River from near the Alberta border at Estuary, east to about Leader, Saskatchewan. Both the northern and southern populations represent extensions of the distribution of the Prairie Rattlesnake northeast from Alberta and north from Montana respectively.

The Eastern Yellow-bellied Racer is known only from a few specimens collected or captured in the Frenchman River Valley (Cook 1978, Mackay 1987) and in the Big Muddy Valley of southern Saskatchewan (Maher and Beck 1964, Morrison 1969, Cook and van Zyll de Jong 1975, Kreba 1978). Like the Prairie Rattlesnake, these populations represent the northern most extent of the species distribution in North America. Virtually nothing is known of the biology or population status of this species in Saskatchewan.

In the autumn of 1987, a survey of Prairie Rattlesnake hibernacula (dens) in Frenchman River Valley was conducted for the Saskatchewan Natural History Society (SNHS). This survey identified five active hibernacula, estimated population composition and size, and provided documentation of an incident of deliberate destruction of 40 to 60 rattlesnakes at one well-known rattlesnake den near Val Marie (Mackay 1987).

The northern population of the Prairie Rattlesnake was the focus of a second study commissioned by the SNHS in 1988. Twelve active dens were identified and a more detailed examination of life-history parameters and demography of this population was made (Macartney and Weichel 1989). This study uncovered recent acts of vandalism and rattlesnake killing at two dens near Leader, Saskatchewan. Potential threats to this population due to human disturbances and land use changes were also identified. A provincial rattlesnake population size estimate based on a minimum of 17 known rattlesnake dens ranged from 1200 to 4000 rattlesnakes.

In 1988, the legal status of the Prairie Rattlesnake in Saskatchewan changed when Order-in-Council (782/88, September 1988) amended the Wildlife Act Regulations (4.1a) by expressly excluding the Prairie Rattlesnake from a list of wildlife not protected by closed or regulated hunting seasons. It thus became illegal to kill or capture rattlesnakes (without a permit) except when landowners are threatened on their own property. The same regulatory amendment was also applied to the Eastern Yellow-bellied Racer and the Short-horned Lizard. This legislation, however, offers no specific protection for the hibernacula used by these species.

In 1990/1991, an additional survey for Prairie Rattlesnake populations in southwestern Saskatchewan was commissioned with funds allocated through the Saskatchewan government's Endangered Species Fund. The objectives were to provide a more detailed investigation of the southern population of the Prairie Rattlesnake to further delineate the distribution of active dens in southwestern Saskatchewan, to collect demographic information for this population, and to identify existing or potential threats to these populations. Concurrent objectives were to gather as much information as possible on the life-history, distribution, and population status of other sympatric reptile species, most notably the Eastern Yellow-bellied Racer, during the course of performing field surveys for rattlesnakes. This species is sympatric over most of the range of the Prairie Rattlesnake in North America, often shares the same hibernacula and thus is often encountered while searching for rattlesnakes.

The findings of the 1988 and 1990 to 1991 surveys formed the basis for management recommendations for the protection and conservation of the Prairie Rattlesnake and the Eastern Yellow-bellied Racer in Saskatchewan. The results presented in this paper are a compilation of the 1988 survey of the northern population and the 1990 to 1991 survey of the southern population.

METHODS

Field work was conducted in the spring, late summer, or early autumn, periods when snakes were present at hibernacula. Hibernacula were located on the basis of information provided by local residents, conservation officers, previous studies and by systematic ground searches carried out in areas that provided suitable topography for hibernacula. We also attempted to confirm historic or recent reports of rattlesnakes or their hibernacula outside of their documented range in the province by conducting telephone and in-person interviews with Prairie Farm Rehabilitation Administration pasture managers, local residents, naturalists, and conservation officers.

The locations of active hibernacula were mapped and inspections of the den site and adjacent habitat were made to determine current land use at the site and look for evidence of natural or man-made disturbance at dens (e.g., erosion, shotgun shells, carcasses, chemical, or structural damage to dens).

On each visit to a hibernacula we attempted to capture and mark as many snakes as possible. Rattlesnakes were captured with Pilstrom tongs and secured for safe handling in a padded restraining noose (Gregory et al. 1989). Non-venomous snakes were captured and restrained by hand. Each snake was sexed by hemipenal eversion (Gregory 1983), its snout-to-vent length (SVL) was measured (stretched out along a metre stick) to the nearest 0.5 cm and the number of rattle segments was counted for every rattlesnake. Snakes were individually marked by removing a unique combination of subcaudal scutes with a pair of scissors (Blanchard and Finster 1933).

Abdominal palpation was used to detect the presence of follicles, eggs, or embryos in female snakes and thereby determine their reproductive status (Macartney and Gregory 1988). Size at sexual maturity was estimated as the SVL of the smallest female found to be gravid or have enlarged follicles (Macartney et al. 1990). All snakes were released to their capture site immediately after processing in the field was completed.

RESULTS

Locations of Rattlesnake Hibernacula

In Saskatchewan, the Prairie Rattlesnake occurs as two small, widely separated, disjunct populations (Figure 1). The northern population is found along a 50 km long stretch of the South Saskatchewan River from the Alberta border near Empress east to about Leader, Saskatchewan. Within this range 12 hibernacula were identified and a total of 130 rattlesnakes were marked during the 1988 survey. Hibernacula in this area were generally situated in areas of slumping topography within a band of about two km from the river. Snakes using these dens are reported to disperse during the summer up to 15 km from the dens, along the river valley floor and upland country, much of which is under cultivation. Numbers of snakes

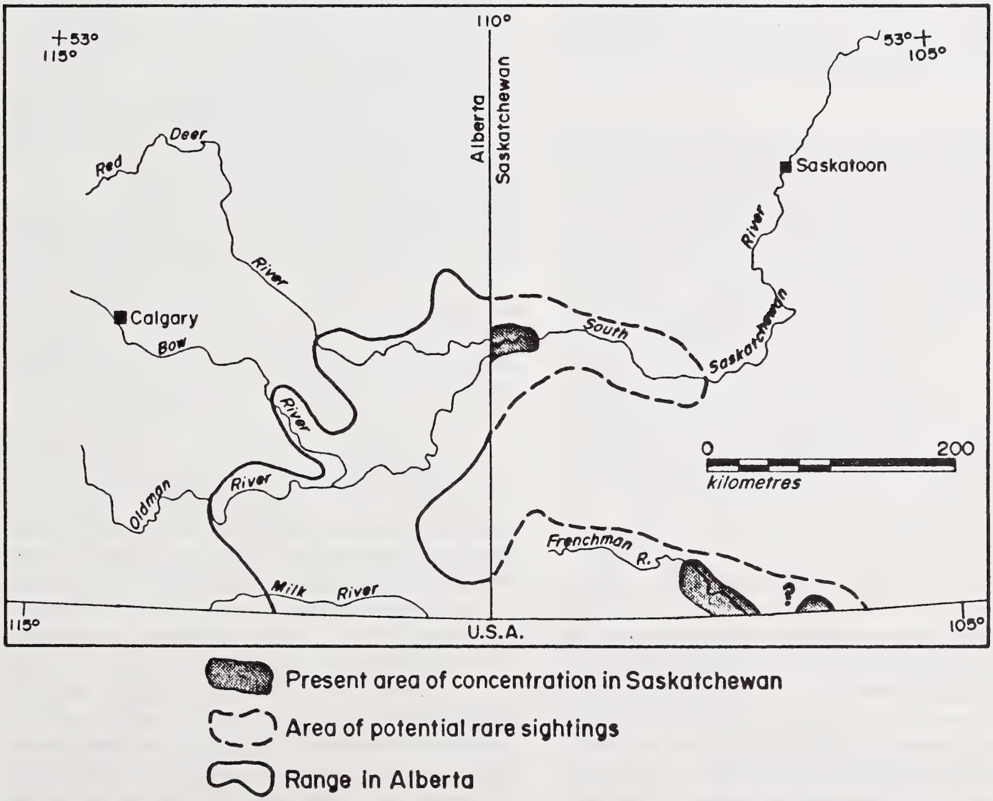

Figure 1. Distribution of Prairie Rattlesnakes in Saskatchewan.

captured at these hibernacula varied from one to 41. Bullsnakes (*Pituophis melanoleucus*) and two species of garter snake were also present in this area and frequently captured at these hibernacula.

In southwestern Saskatchewan, the occurrence of Prairie Rattlesnakes appears to be limited to the Frenchman River Valley from Val Marie southeast to the Montana border. Historical records of rattlesnake sightings outside of this area were not substantiated by our surveys, although the possibility of rattlesnakes occurring within the proposed East Block of Grasslands National Park cannot be ruled out. Poor weather and difficult access prevented a thorough search of the area in 1990. Our searches within the Frenchman River Valley confirmed the continuing existence of the five hibernacula identified as "active" by Mackay in 1987, and led to the discovery of five additional rattlesnake hibernacula and one hibernacula used by several species of colubrid snakes. A total of 236 rattlesnakes was captured and marked, with den population sizes ranging from one to 131. Bullsnakes, the Plains Garter Snake (*Thamnophis radix*), and Eastern Yellow-bellied Racers were also found at hibernacula in this area.

Twenty-three Eastern Yellow-bellied Racers were captured and marked during the 1990/1991 survey of the Frenchman River Valley rattlesnake dens. All of them were found at or near entrances to communal hibernacula. Remains of four other racers were found at one hibernacula, these included two neonates and two adult racers that had been killed and partially consumed by some mammal (Badgers [*Taxidea taxus*], Striped Skunks [*Mephitis mephitis*], or other mustelids) and by raptors (Swainson's Hawk [*Buteo swainsoni*]). Eastern Yellow-bellied Racers were seen or captured at nine of 10 hibernacula in the Frenchman River Valley during 1990/1991, whereas Mackay (1987) observed racers at just two of the five dens in the same area.

Most of the hibernacula in the province are found on Crown land used for grazing and eight of the 12 dens near Leader are on lands already designated under the Critical Wildlife Habitat Protection Act (CWHPA). Of the twelve snake dens in the south, 11 are on land that is either presently within, or soon will be within, the proposed boundaries of Grasslands National Park. About one-half of the hibernacula had received some amount of human visitation, as evident by the presence of garbage, shotgun shells, damage to den entrances, etc. Acts of deliberate killing of rattlesnakes were documented by Mackay at a den near Val Marie in 1987. We learned of recent attempts to kill rattlesnakes and destroy dens with flammable materials at two hibernacula in the Leader area. These appeared to be isolated events carried out by misguided individuals and did not reflect the general attitude of residents in either area. As far as we can determine, there has not been any commercial harvesting of rattlesnakes in the province.

Life-History Parameters Of Prairie Rattlesnakes

Growth

Since snakes generally do not have external markers of age, it is often very difficult to accurately age snakes on the basis of size, especially when growth rates are unknown. In rattlesnakes, a new rattle segment is added to the base of the existing string of rattles each time the snake undergoes ecdysis (sheds). Therefore, the number of segments on the rattles is a potential indicator of age if the rattle string is intact and the frequency of ecdysis is known. Recapture of marked snakes over one growing season can provide information on growth and frequency of ecdysis; unfortunately, large numbers of snakes must be marked in order to obtain even a handful of recaptures.

In our studies we recaptured a few adult rattlesnakes, none of which showed any measurable growth during the interval. We suspect that most yearling rattlesnakes may shed one to three times and assumed that on average they shed twice per annum until adult size (about 800 mm SVL) is attained. Adults appear to shed just once during the active season.

An approximate growth curve was generated based on mean SVL of juveniles in rattle size classes for the northern population (Figure 2). Growth data for the southern population is very similar. Based on a shedding frequency outlined above the average rattlesnake would attain an adult size of about 800 mm SVL during it's fourth growing season.

Reproduction

The smallest female Prairie Rattlesnake that contained enlarged follicles or embryos was 785 mm SVL and had seven rattles plus the button (7+B). According to the growth curve, this female was mated either during the end of her third or fourth growing season and would deliver her litter at the end of her fourth or fifth year. Other females would not likely mature at

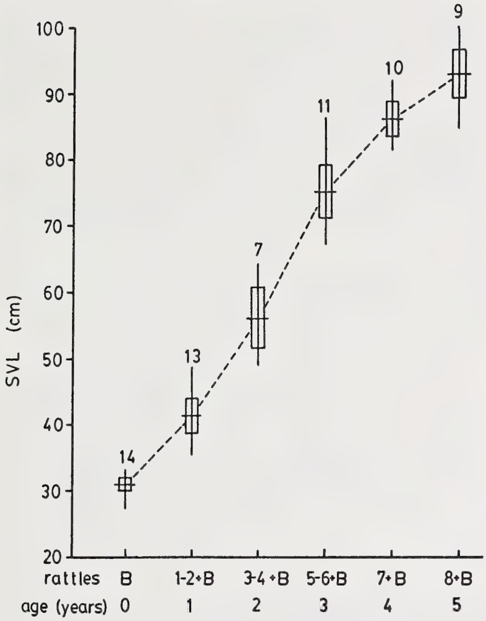

Figure 2. Growth curve for juvenile Prairie Rattlesnakes (sexes pooled) in the northern population, based on body size distribution in rattle size classes. Approximate age classes corresponding to each rattle class is also shown. Horizontal line = mean SVL, vertical line = SVL range, rectangle = 2 S.E.

this early an age. Enlarged follicles were seldom palpated in females less than 840 mm SVL thus it is probable the majority of females would attain sexual maturation at four or five years and produce their first litter in the fall of their fifth or sixth year.

Mean litter size based on abdominal palpation of enlarged follicles or embryos in gravid females in the southern population was 10.2 (SE = 0.8, n = 25, range = 8 - 16 young) and in the northern population it was 8.2 (SE = 0.3, n = 30, range = 4 - 11). There are reliable reports of litters of 20 to 30 young born in captivity to some large females from the Frenchman River Valley (Lise Perrault, pers. comm.).

Timing of parturition is likely to vary slightly from year-to-year and among individuals. In Saskatchewan post-parturient females and neonates are encountered in late August and early September. The mean size of neonate rattlesnakes based on measurements of neonates captured shortly after parturition was 260 mm SVL for the southern population (SE = 2.3, n = 49, range 215 - 280 mm) and 308 mm (SE = 4.3, n = 14, range 270 - 335) in the northern population. There was no sexual-size dimorphism at birth in either population.

Reproductive frequency is best determined by following reproductive histories of individual females over several years, but in short-term studies this is not possible. Another approach is to examine the ratio of gravid to non-gravid females in a population. A 1:1 ratio suggests a reproductive cycle that is at least biennial, i.e., a litter every other year (Macartney and Gregory 1988). We pooled data for mature females (SVL 830 mm SVL, n = 40) from the southern population and calculated the ratio of gravid: non-gravid females to be 0.6:1. For the northern population the same ratio was 0.7:1 (n = 31 adult females). Thus we have a cycle that is at least biennial in these populations. Whether all females in these populations reproduce this often will be influenced by their ability to recuperate body reserves during the non-gravid year. Multi-year mark-recapture studies are needed to verify reproductive frequency; however, we suspect that biennial or triennial reproductive cycles are the most common for female rattlesnakes in Saskatchewan.

Population Composition

Because of low numbers of snakes captured at most den sites, demographic characteristics were analyzed using data pooled for individuals from all dens. Population structure based on spring and autumn sampling included a large proportion of neonates, low numbers of yearlings, an increasing numbers of subadults, and a predominance of adults (Figures 3 and 4).

Another biological parameter illustrated in these figures is that male rattlesnakes generally attain a larger adult size than female rattlesnakes. The largest male was 1350 mm SVL while the largest female was 1194 mm SVL. The sex ratio in the southern population was 1.5:1, males:females (n = 236) in the northern population the ratio was 1:1.1 males:females (n = 130).

The population composition recorded by Mackay at the five dens in the Frenchman River Valley in 1987 differed somewhat from our 1990/1991 study. In general, however, hibernacula that were used by many snakes in 1987, continued to support relatively large populations in 1990/1991, whereas dens at which few snakes were found in 1987 also had few snakes in 1990/91.

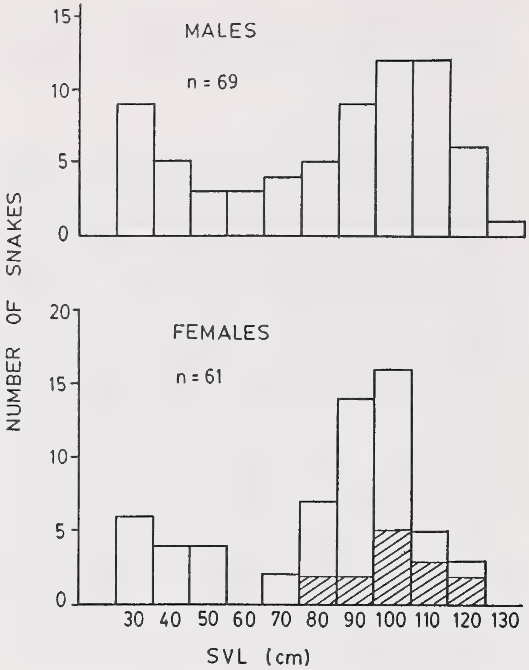

Figure 3. Size-frequency histograms for the northern Prairie Rattlesnake population in Saskatchewan. SVL = snout-vent length and hatched areas represent females with enlarged follicles in autumn sample.

Provincial Population Size

Estimating the number of Prairie Rattlesnakes in Saskatchewan is a difficult task. Doubtless we have not located all the hibernacula in the province, so any estimate based on the known hibernacula is likely to be very inaccurate and at best a conservative estimate. In our 1988 study we applied a factor of 6 multiplied by the number of captured snakes at a den in order estimate total den populations. This factor was derived from data obtained during a similar, but longer term, mark-recapture study on the Northern Pacific Rattlesnake (*Crotalus viridis oreganus*) in British Columbia, in which over a three year period up to 95% of rattlesnakes at given dens were marked (Macartney 1985). On average, population size estimates based on the Jolly-Seber method at these dens were six times higher than the numbers of snakes that were captured during the first spring in which these dens were sampled. We are really just extrapolating to compensate for the fact that we had relatively little time to sample at any of the Saskatchewan dens (1 to 6 visits per den).

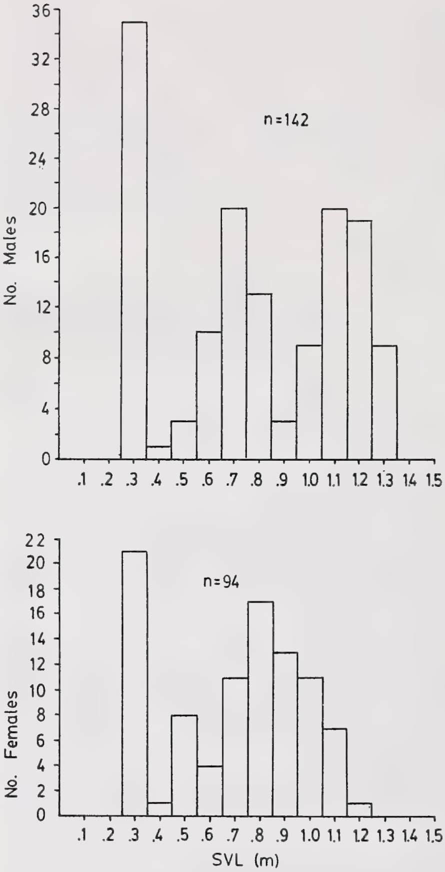

Figure 4. Size-frequency histograms for the southern Prairie Rattlesnake population in Saskatchewan. SVL = snout-vent length.

If we apply this correction factor to the total number of snakes marked at all dens in the province an estimate of about 2200 rattlesnakes is obtained. We can probably easily double this figure to compensate for the suspected number of dens we have not found. Thus a conservative range for the size of the Prairie Rattlesnake population in Saskatchewan is 2000 to 4500 individual snakes.

Life-History Parameters of the Eastern Yellow-bellied Racer

There is currently no information to indicate that the racer exists anywhere in Saskatchewan except for the two river valleys mentioned above (Didiuk 1986). Both Mackay's 1987 study and the present study suggest that densities may be quite low, with less than 10 individual snakes using a given den. However, racers also hibernated at sites other than those used by rattlesnakes and there likely are many other denning sites in the Frenchman River Valley that are used by racers. The continued existence of the Big Muddy area population has not be confirmed for over a decade.

Racers are oviparous, laying small clutches of eggs in June or July that hatch in August or September. Neonates are between 230 to 250 mm SVL. They have a distinct, mottled reddish-brown dorsal colour pattern, resembling young Bullsnakes more so than the solid greenish-blue colour pattern of adult racers. The ventral surface of neonate and juvenile racers is pale yellow with an orange spot on the lateral margins of each ventral scute. The dorsal patches and the ventral orange spots fade as snakes mature and are absent in adults.

We captured one neonate (230 mm SVL) and a small racer (445 mm SVL) with a distinct juvenile pattern that was probably one year old. Three somewhat larger racers (515, 585, and 610 mm SVL) had adult dorsal colouration and yet retained juvenile ventral spots. These snakes were likely in their second year of growth. All racers 615 mm SVL had adult colouration and pattern. If the loss of juvenile markings signifies attainment of sexual maturity, then racers in Saskatchewan probably mature during their third year.

Data we collected during this study were not sufficient to make accurate comments about demography of racer populations. A size frequency histogram is presented in Figure 5. The sex ratio based on the small sample of snakes was 1.3 male: 1 female.

DISCUSSION

Significance Of Demography

The results of this study revealed many similarities in life-history parameters between the northern and southern populations of the Prairie Rattlesnake in Saskatchewan. In general, there is close agreement in terms of growth rates and age at sexual maturity and first reproduction, and in maximum body size measurements. Biennial or triennial reproductive cycles are likely present in both populations. The average litter size of 10.2 young was greater than the mean of 8.2 calculated for the northern sub-population. However, a greater SVL range of females was sampled in the latter sub-population and thus smaller females with correspondingly smaller litters (there is a direct, although not a strong, correlation between body size and litter size in rattlesnakes) would tend to have lowered the estimated average litter size.

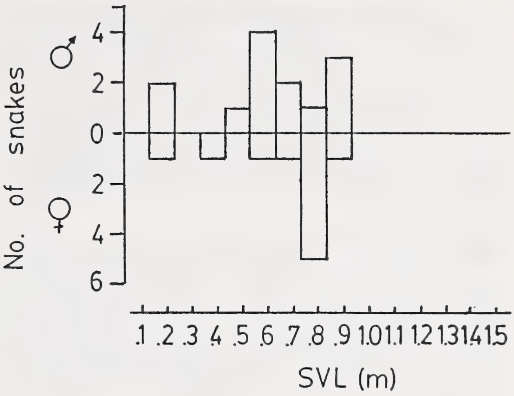

Figure 5. Size-frequency histogram for the Eastern Yellow-bellied Racer population marked in the Frenchman River Valley, Saskatchewan.

The size-frequency histograms for the northern and southern sub-populations showed similar patterns of population structure. These populations are dominated by subadults and adults and appear to have moderately high annual recruitment of neonates. In both populations juvenile snakes are under-represented. These histograms illustrate a practically universal feature of rattlesnake populations in general: very poor neonatal and juvenile survivorship (Macartney 1985, Parker and Plummer 1987). The near absence of juveniles at hibernacula may suggest that juveniles may hibernate in sites other than their natal den or it may also reflect the fact that juveniles are more cryptic and harder to find and capture at dens than adults, and their under representation is a sampling artifact. Studies on more intensely sampled populations of the Northern Pacific Rattlesnake in British Columbia, suggest that the lack of juveniles is due to very low annual survivorship of neonates and yearling rattlesnakes and not due to sampling difficulties (Macartney 1985).

The combined effects of relatively slow growth and late sexual maturation, infrequent reproduction, small litter size, and poor juvenile survivorship result in populations that are very slow to increase size or change in composition, i.e., they are relatively stable over long periods of time. The stability occurs because annual survivorship of adults is high and because rattlesnakes are fairly long-lived animals (estimated age of large adult Northern Pacific Rattlesnakes is greater than 20 years (Macartney et al. 1990), thus a stable core of adult snakes serves as a buffer during those years when reproduction or juvenile survivorship is particularly poor.

The fact that we noted little change in the relative numbers of snakes at the five dens in the Frenchman River Valley after a three year hiatus is consistent with the population dynamics described above, i.e., any noticeable change in population size or composition is likely to occur very gradually.

Rattlesnake populations are most susceptible to catastrophic events such as large-scale illegal harvesting and alterations to hibernacula (natural or man-made) since these may rapidly and drastically reduce the size and alter the composition of populations. Furthermore, Prairie Rattlesnake dens in the Frenchman River valley and along the South Saskatchewan River are widely separated and neighbouring den populations would provide very minor sources of recruitment through emigration. Therefore, if adult snakes are preferentially removed from the population as occurs when rattlesnake hunters seek "trophy" sized animals or their parts, then it will require an even longer period for the number of reproductive mature females to build back up in the population and for their offspring to then enter the adult population. Following such an event, a period of several decades may be necessary for the den populations to recover to former levels.

To date, the principle recognized threat to rattlesnakes has been human disturbance at dens. Malicious hunting/slaughter of snakes at dens has been documented for both populations in Saskatchewan the recent past. In our experience, there are usually one or two dens whose locations are known to most persons living in a given region. These sites tend to be the most readily accessible and therefore, receive the brunt of the visitation by the curious and are most likely to be the target of misguided individuals who wish to harm snakes or dens. These sites also tend to be more frequently monitored by concerned individuals or agencies responsible for protecting rattlesnakes or their hibernating sites, therefore, acts of vandalism are more likely to be recorded when they occur at these sites.

Most of the hibernacula in Saskatchewan are on lands leased for grazing cattle. Stocking densities of livestock are low and vegetation is sparse around most dens, so they do not "attract" increase usage by cattle. Overgrazing and trampling of soils and vegetation near denning areas may affect soil stability around dens, but we found no evidence that this is a significant problem at hibernacula. Some degree of soil erosion causing the partial occlusion of den entrance ways after heavy summer rains seems to be common at many of the dens. Whether this reflects normal soil erosion processes for these areas or is the effect of overgrazing near dens is not known.

The affect that farming practices (e.g., cereal crop production) has had on the quality of foraging habitat for rattlesnakes is largely unknown, but we do know that in both the northern and southern populations, den sites are often closely situated to cultivated fields and that snakes sometime make lengthy migrations away from the dens into or through these areas. Cereal crop production, when compared to undisturbed upland or valley floor prairie grassland habitat, may provide lower quality habitat for snakes to forage in because the homogeneity of the vegetation may reduce the numbers and diversity of small mammals and birds that make up the bulk of the rattlesnake's diet. There is also some incidental mortality of snakes on roads (and possibly in fields during crop harvest).

Like the Prairie Rattlesnake, the main potential threats to Eastern Yellow-bellied Racer populations are loss of habitat (especially denning areas) and direct human hunting/collecting of racers. Road mortality is an easily recognized cause of mortality but is likely to be insignificant compared to mortality from natural predation.

At present, there is no solid evidence to suggest that Prairie Rattlesnake and Eastern Yellow-bellied Racer populations are declining in this province. The 1990/1991 survey discovered more hibernacula and snakes of both species than have ever been collected or observed in previous history for this province. This means little because surveys of this intensity had not been conducted before. These species have probably never been very common or widespread in this province and their occurrence in remote, largely uninhabited, and inaccessible areas has probably meant that populations have been largely undisturbed during historical times.

Since these species have been legally protected from hunting since 1988, the main focus of protection should now be placed on the hibernacula since these figure prominently in the life-history of snakes and because they are not a readily renewable resource. The remoteness and inaccessibility of most hibernating sites has probably been the main reason why a majority of rattlesnake dens have not been disturbed and will continue to receive little human disturbance. What we don't know and should probably be addressing in the future is the question of how large an area around a den needs to be available to snakes in order for them to continue to survive in these areas? Telemetry studies may prove very helpful in finding out where snakes disperse to during summer months and whether agricultural practices have any effect on dispersal patterns, foraging success, and predation.

Finally, our main management recommendations for conserving these species are that there should be: 1) ongoing annual monitoring of known dens, 2) encouragement of landowners and grazing lessees to report rattlesnake and racer sightings, 3) incentives for these individuals to protect against the malicious hunting of rattlesnakes or damage to hibernacula on their property, 4) public education in communities situated in rattlesnake country, 5) designation under the CWHPA for all quarter sections on which snake hibernacula are present, and 6) that individuals who are found to have altered dens so as to make them unusable by rattlesnakes or racers should be charged under both the CWHPA and the Wildlife Act.

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THE CARBERRY SANDHILLS OF SOUTHWESTERN MANITOBA; THE NEED FOR ACTIVE MANAGEMENT

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INTRODUCTION

Over a 30 year period, while studying the Northern Prairie Skink (*Eumeces s. septentrionalis*) and other interesting members of the Carberry Sandhills ecosystem, it became apparent to me that relationships between plant communities were changing. The most notable change was the rate at which the native mixed grass prairie, and spruce-prairie associations were disappearing. Initially, I noticed small, sucker patches of aspen appearing in low, moist hollows. These patches quickly began to spread. Small clonal bluffs grew larger, and in places merged into the beginnings of a forest. In the 1970s, I became alarmed at the number and size of Leafy Spurge (*Euphorbia esula*) patches east of Canadian Forces Base (CFB) Shilo. Today, most areas of both the military range at Shilo and Spruce Woods Provincial Park glow a distinctive yellow-green in early spring, the color of this noxious weed.

Beginning in 1981, while conducting a study on the status of the Northern Prairie Skink for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), I began to look at the factors affecting the mixed grasslands where the skinks occur.

Many variables affect the succession of one plant community to another. A major factor is the moisture condition, where dry periods favour grasslands and wet periods favor the aspen woodlands. There is a constant tension between the two communities, yet, if left unchecked, Aspen (*Populus tremuloides*) will eventually cover the grassland. While looking closely at vulnerable species such as the Northern Prairie Skink, I observed the rapidly shrinking boundaries of one of the last major remnants of native mixed grass prairie.

HABITAT

The Carberry Sandhills were formed some 12,000 years ago when the Assiniboine River, swollen with glacial melt water, poured into Glacial Lake Agassiz forming the Upper Assiniboine Delta. In places these Ice Age deltaic deposits are 60 to 80 m deep. Following the recession of the Wisconsin ice sheet and drainage and reduction in size of Lake Agassiz, the sands of the delta lay exposed. Strong winds tossed up massive dunes over an area of some 1770 km^2. Slowly, the shifting sands were stabilized with vegetation.

Ritchie (1966), in analyzing pollen from core samples spanning 12,500 years, found the initial dominant vegetation in the area to have been White Spruce (*Picea glauca*) with grasslands. It is only in recent times that pollen records show a deciduous forest influence. Today this spruce-grassland flora remains as a last vestige of the Ice Age, a relict of past glacial times without equal in Canada.

Ehrlich et al. (1957) gives this description of the Carberry Sandhills: "The topography is very gently undulating except in areas of duned sand. The dunes are intermixed longitudinal and crescent shaped and have sharp faces which generally face north and east. Soil drainage is good to excessive. The native vegetation on the very gently undulating topography is intermixed grassland and aspen-oak woods. On the sand dunes the vegetation varies with position and exposure. The north and east facing slopes are favourable regeneration sites for trees and are covered with Aspen, Bur Oak (*Quercus macrocarpa*), and White Spruce. The tops of the dunes are covered by occasional spruce with an undergrowth of ground cedar and mixed prairie grasses. On the south and west slopes, mixed grasses and herbs are the predominant vegetation." Scoggan (1953) notes that the Sandhills is one of the few sites in the province where true prairie flora is preserved.

Soil-type is the major limiting factor in the Manitoba distribution of skinks. They require an open surface cover of mixed grass prairie, yet it is the loose, sandy soil that allows them to easily burrow well below the frostline in winter (Bredin 1981, 1989).

THE NORTHERN PRAIRIE SKINK

The Northern Prairie Skink is a member of the lizard family *Scincidae*. This family is widespread, occurring throughout temperate and tropical regions of the world. The most recent estimate of 86 genera and 1275 species (Haliday and Adler 1986) ranks it as the largest lizard family.

The genus *Eumeces* is widely distributed in both the old and new worlds and contains 46 (Dowling and Duellman 1973) or 35 species (Smith and Brodie 1982), 12 of which occur in North America, three of these ranging northward into Canada (Cook 1984). The Northern Prairie Skink is found in Canada only in southwestern Manitoba. It is the sole skink species in the prairie provinces; one species occurs in Ontario and one in British Columbia.

In common with other small skinks, *Eumeces septentrionalis* is cylindrical, cigar-shaped with relatively small legs. It is olive to olive-brown above, dark on the sides, with seven longitudinal light stripes, the dorsal three often obscure, particularly in mature males. Adults are 130 to 206 mm in total length. The tail is bright blue in hatchlings but fades to steel grey in adults. Mature males develop a deep reddish orange on the sides of the head and throat during the breeding season.

The Northern Prairie Skink is the most unique member of Manitoba's herpetofauna. The small, isolated population of this small lizard in Manitoba is cut off from the continuous range, which reaches its northern apex in Minnesota and southeastern North Dakota. Its distribution is from southwestern Manitoba to the Gulf Coast of Texas; east to western Wisconsin, western and central Iowa and barely into western Arkansas and Louisiana; west to southeastern North Dakota, eastern South Dakota, central Kansas, Oklahoma, and eastern Texas.

The earliest documentation of this skink in Manitoba was a watercolor by Norman Criddle dated May, 23 1898. Correct identification (Patch 1934) did not come until a Manitoba specimen collected by Talbot Criddle from "Aweme" July 2, 1929 was forwarded to the National Museum of Canada by Norman Criddle.

The distribution of the skink in southwestern Manitoba (Figure 1), its life history and related data (Table 1) is well documented (Bredin 1981, 1988a, 1988b, 1989). This information was gathered by marking, releasing, and re-capturing individuals at two study locations, one on the CFB Shilo ranges and one on Crown land just west of Carberry. The Shilo study area produced 74 marked skinks from 11 different sites, the Carberry study area has produced, to date, 91 skinks from six different sites.

Habitat essential to the Northern Prairie Skink constitutes the portions of native mixed grass prairie and associated forbs remaining in the Carberry Sandhills. The most favoured locations are south and west facing slopes. Skinks are not found in areas of tree cover, nor are they found in association with Leafy Spurge.

Succession from prairie to aspen parkland is resulting in a continued loss of open prairie essential to the skink. That, combined with the rapid spread of Leafy Spurge over existing native prairie, poses a serious threat to this species.

Because of its restricted range, geographic disjunction, and dependence on a restricted habitat, the Northern Prairie Skink has been given the status vulnerable in Manitoba. A large portion of its range lies within areas already protected by their designations as Provincial Park, Forest Reserve, Military Area, Crown lands, etc., that preserves essential habitat from development. The skink has never been commercially exploited and can be collected only under permit as provided by provincial regulations. However, the possible

Table 1. The annual cycle of the Northern Prairie Skink in Manitoba.Table 1.

Activity	Earliest Date	Average Date
1) Emergence from hibernation	April 18	May 5-10
2) Males showing breeding color	May 1	May 10-18
3) Peak breeding season (gestation 40 days)		May 25-30
4) Females laying eggs (average clutch 8 eggs)	June 20	July 2-8
5) Appearance of hatchlings (incubation 35 days)	July 21	August 4-8
6) latest sighting		September 9

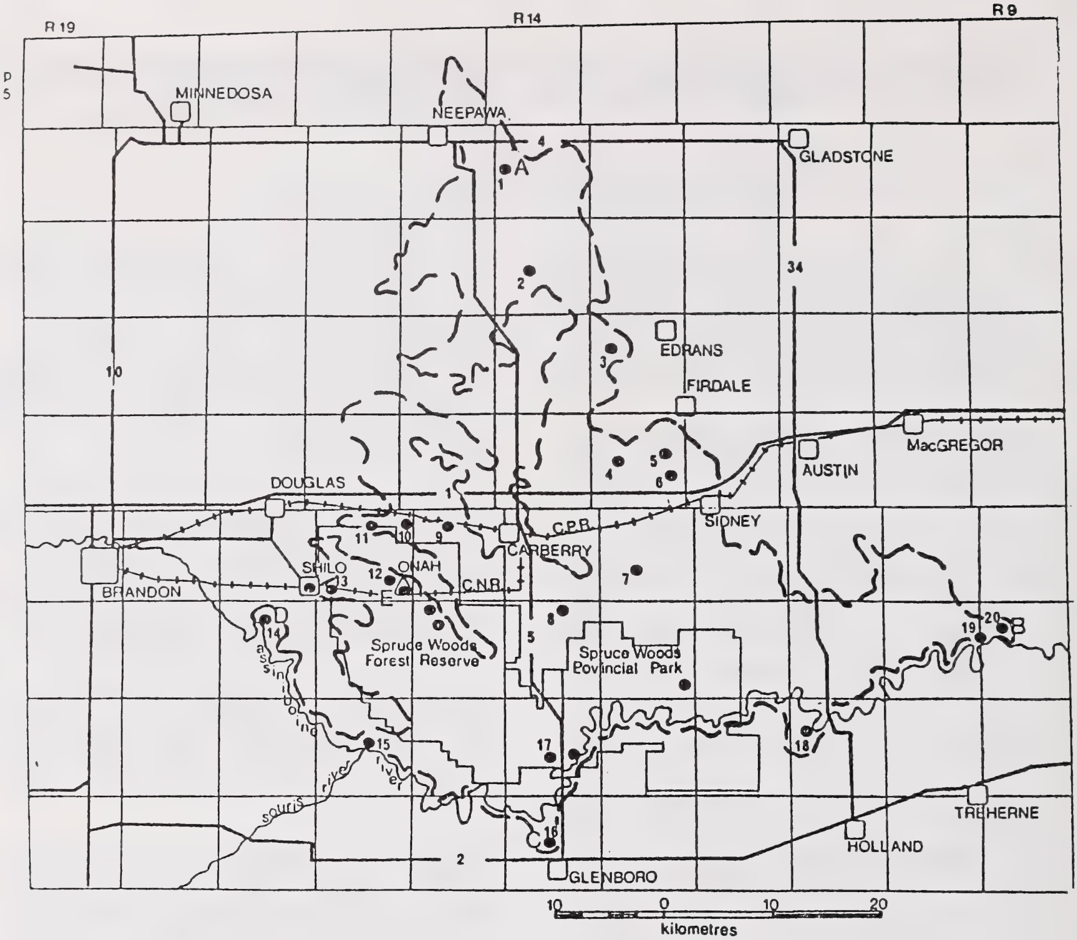

Figure 1. Map of southern Manitoba showing the extent of sandy soils of the Upper Assiniboine Delta region (dashed line) and localities where Northern Prairie Skinks have been recorded (solid circles).

continued invasion of prairie habitat by aspen woodland and the unchecked spread of Leafy Spurge in the area may cause significant detrimental modification of essential aspects of its habitat. If population declines coinciding with such habitat alternations are subsequently documented, consideration of a revision to threatened status could quickly become necessary.

Succession of Mixed Grassland to Aspen Woodland

Since the period of settlement 1870 to 1900, when pioneers invaded southwestern Manitoba, there has been a rapid change in the prairie landscape. Much of the virgin grassland has been lost to domestic crop cultivation. Some areas were not suitable for agricultural use and it is these small remnants that are now priceless and must be managed.

Because of the light, sandy soil and the marked ridges, the Carberry Sandhills were left untouched by early settlers. With the leasing of a large tract of land to the Department of National Defence and later, the establishment of Spruce Woods Provincial Park, large portions of the Sandhills remain untouched by human developments. Yet, being left so, there is as dramatic a change occurring as if these lands had been opened with the plow. These changes are taking place primarily on unused portions of the Shilo ranges and throughout Spruce Woods Park.

Ernest Thompson Seton, world renowned naturalist and Carberry resident for several years, was, in 1884, concerned at how quickly aspen growth was invading native grassland. Ehrlich et al. (1957), in commenting on the Carberry Sandhills, states: "Aspen is the most prevalent species, ranging from small groves invading the grassland through larger and irregular clumps to closed woodland stands." Nero (1976), in an article on the Sandhills mentions: "Some people have suggested that the area be maintained in a natural state but this is not an easy matter. Ecological succession in the absence of fire favors trembling aspen, this tree species now dominates much of the area closing in on the spruce and overriding the prairie grasslands. Should the area come under management for wildlife and scenic values, some use of controlled fire would probably be necessary. Ecologists maintain that the large number of accidental fires within the CFB Shilo military reservation (in Spruce Woods Provincial Forest) has been beneficial in keeping the forest open and attractive to big game."

When travelling through the Carberry Sandhills, a marked variation is seen. In the active range area of CFB Shilo, there occurs wide expanses of open, undulating grassland. The topography is dotted here and there with clumps of White Spruce. It is a striking landscape without aspen groves. The shrubs and big game flourishes along with species such as the skink, and other rare flora and fauna of the grassland. Each year, exploding shells set off grass fires that burn off expanses of prairie. The result is a viable, healthy grassland.

As one travels away from the active military range, aspen groves thicken and the ratio of grassland to aspen woodland reverses itself. There are only small clearings of native prairie.

Other rare flora and fauna associated with the native prairie and the "open dune" habitat near Spruce Woods Park include: the Loggerhead Shrike (*Lanius ludovicianus*), Baird's Sparrow (*Ammodramus bairdii*), Cooper's Hawk (*Accipiter cooperii*), Upland Sandpiper (*Bartramia longicauda*), Eastern Bluebird (*Sialia sialis*), Sprague's Pipit (*Anthus spragueii*), Chestnut-collared Longspur (*Calcarius ornatus*), Rufous-sided Towhees (*Pipilo erythrophthalmus*), Brown Thrashers (*Toxostoma rufum*), Olive-backed Pocket Mouse (*Perognathus fasciatus*), Northern Grasshopper Mouse (*Onychomys leucogaster*), Tooth Field Grasshopper Tiger (family *Cicindelidae*), and Goldsmith Beetles (family *Crysamiladae*). Grouse leks occur on the higher quality open prairie.

The prairie is dominated by such grasses as: Blue Grama (*Bouteloua gracilis*), Spear Grass (*Stipa comata*), June Grass (*Koeleria macrantha*), Green Needle Grass (*Stipa viridula*), Awned Wheat Grass (*Agropyron trachycaulum*), Sand Grass (*Calamovilfa longifolia*), Canada Wild Rye (*Elymus canadensis*), and Little Bluestem (*Andropogon scoparius*). Other important native prairie plants include Prairie Sagewort (*Artemisia ludoviciana*), Pasture Sagewort (*A. frigida*), Prairie Crocus (*Anemone patens*), Three Flowered Avens (*Geum triflorum*), Spike Moss (*Selaginella densa*), Dotted Blazing Star (*Liatris punctata*), Prairie Onion (*Allium textile*), Beautiful Sunflower (*Helianthus subrhomboideus*), Purple Prairie Clover (*Petalostemon purpureum*), Owl-clover (*Orthocarpus luteus*), Sand Cherry (*Prunus pumila*), Low Goldenrod (*Solidago missouriensis*), Golden Aster (*Heterotheca villosa*), Many Flowered Aster (*Aster ericoides*), Smooth Aster (*Aster laevis*), and Common Wild Rose (*Rosa woodsii*).

The constant encroachment of aspen and the spread of Leafy Spurge threatens the aforementioned species and all of the more common inhabitants of the prairie ecosystem.

Leafy Spurge

Leafy Spurge is a dicotyledonous, herbaceous, deep rooted perennial of the spurge, *Euphorbiaceae* family. The most conspicuous features of the plant are the yellowish-green flower-like clusters borne on umbels at the tip of the stem. Each stalk can produce from 25 to 150 seeds. It is allelopathic in nature (Galitz and Davis 1983) and apparently suppresses growth and development of other plant species around it. It has been demonstrated (Letourneau et al. 1956, Selleck et al. 1962) that components of various aqueous and organic solvent extracts from Leafy Spurge suppress germination and seedling growth in other plant species.

Calvin G. Messersmith, Professor of Agronomy, North Dakota State University, in personal communication, writes: "Those of us who work with Leafy Spurge see it spread rather quickly, i.e., big changes over three to five years. The estimated acreage in North Dakota has increased from 423,000 acres in

1973 to 1.2 million acres in 1987. All it takes is one plant to start a new patch and patches more than a few months old are difficult to eradicate."

Leafy Spurge is an introduced species from Europe, first observed in North America at Newbury, Massachusetts in 1827. It was first noted in Manitoba on a farm near Rounthwaite in 1900 by Norman Criddle (Bird 1961). In 1950, the Manitoba Weeds Commission surveyed the CFB Shilo range area and counted 1435 separate patches.

It is one of the first plants to emerge in spring. In my study area it was the first plant species to show signs of growth. Spring growth was detected by April 2, and by April 19, shoots were up 8 cm and by April 22, patches showed shoot development of 11-12 cm. By April 27, flower clusters were forming on umbels.

Once established in a satisfactory location the normal movement of skinks consists of short forays radiating out from a piece of surface cover. Research has indicated these forays seldom exceeds two metres in any direction. During the breeding season young males are inclined to wander further a field in search of females. Indications are that this transitory movement is around the parameters of an established population. Under normal conditions there is never a wholesale relocation of a given population. It appears to only occur when Leafy Spurge invades the site of an established population or when a spreading poplar grove creeps into the immediate area.

In the early 1980s I became increasingly alarmed with the amount of Leafy Spurge showing up throughout the Sandhills. Initially, my concern was that large open expanses of mixed grassland were being entirely taken over by this weed and other, native plant species were being eliminated. The impact of Leafy Spurge on the Northern Prairie Skink began to show itself through concentrated field work beginning in 1983. From 1978 to 1983, I recorded a wholesale movement of skinks from one area where a patch of Leafy Spurge had begun to establish itself to another location offering reduced cover. The spurge quickly covered the entire south-facing ridge where marked skinks had been located. These marked individuals were being recaptured up to 60 m away from the point of first capture and for skinks this is a very significant move.

This prompted further study and I visited other areas where skinks had been sighted through the years. In three locations, existing populations of skinks had disappeared with the appearance of Leafy Spurge. It is perhaps the loss of natural cover along with a reduction of available food that forces skinks to relocate when spurge moves in.

Chemical control of this plant is neither feasible nor desirable in the Carberry Sandhills. The cost of such a program is prohibitive; more importantly, many rare and endangered broadleaf species of native flora would be killed.

There is an effort being funded by the Department of National Defence for the biological control of Leafy Spurge. This appears to be the most practical alternative for control of this weed. Because of its genetic diversity some feel that at least four to six spurge destroying insect species and/or diseases will have to be established for a biological control program to be successful.

CONCLUSION

The objective of this third Workshop includes how to implement World Wildlife Fund (WWF) Canada's Prairie Conservation Action Plan (PCAP) and to encourage recovery efforts for species in jeopardy. The PCAP (WWF 1988, page 4) states, "Loss of habitat is the most critical issue for wildlife. The potential for species extinctions in the prairies is a matter of serious concern." The Shilo Military Range in Manitoba is one of the largest aspen parkland areas left in Canada. Under the heading: "Aspen Parkland Ecoregion," the PCAP recommends (page 14): "cooperative conservation efforts between the DND and the Manitoba Department of Natural Resources should be maintained to ensure protection of the flora and fauna in the Shilo area."

Initiatives to implement effective and active management of this threatened, limited resource have been taken by the Department of National Defence (DND), but no such measures currently exist for Spruce Woods Park. There is a grave irony in all this. Manitoba Natural Resources - Parks issued a bulletin in July 1989 titled "Public Consultation on a Management Plan for Spruce Woods Provincial Heritage Park." It mentions the park is a natural treasure and goes on to state: "One of the most outstanding provincial parks in the system. It will take the best possible management plan to guarantee that the park continues to offer its remarkable recreational activities to Manitobans and visitors to the province."

A final park management plan was to be in place by December 1990, instead it's on indefinite hold. Apparently a "sustainable development" paper will be coming out this year (1992) on all parks in the provincial system. This is meaningless in regard to Spruce Woods. It only allows the deterioration, and succession to continue—a year makes a difference.

I say this out of deep concern because the DND is taking positive steps to manage the portion of the Sandhills they control. The military has played and continues to play a significant role in conserving Manitoba's native prairie heritage. An Environmental Protection Plan will be drafted for the military ranges this year and it is my sincere hope that Manitoba Parks takes a look at it and implements a similar plan for Spruce Woods Provincial Park.

Hind (1859), Seton (1909), Criddle (1911), Scoggan (1953), Ehrlich et al. (1957), Bird (1961), Nero (1976), all discuss a loss of native prairie and give reasons why. I have talked with local residents who recall a time around the turn of the century when there was hardly an aspen to be seen and no Leafy Spurge. Over the past 30 years I have watched the prairie disappear, not lost to cultivation, but lost to mis-management.

Before the influx of settlers, the control of the prairie fires and the elimination of the Plains Bison (*Bison b. bison*), the grasslands were doing just fine. So little native prairie is left. To set aside, as a park, such fragile habitat and feel that the grasslands, aspen woodland, and other important plant communities will coexist in harmonious equilibrium is foolhardy.

My association with the Carberry Sandhills began as a child. It was a wilderness full of adventure. As I matured, my interests did also, I observed the "hills" with scientific interest. I now feel a relationship with this land that transcends the disciplines of science, it speaks to me in ways words cannot describe—on the one hand a child-like wonder for its beauty and mystery, on the other, a profound agony, a sense of loss.

I end by quoting from the PCAP: "Living things are an important part of the world we live in—they impart not only economically and scientifically useful resources, but also much in the way of beauty, inspiration, recreation, cultural and spiritual value. They affect our quality of life, and help define who we are as Westerners and Canadians."

"In short, if we want wildlife (species), a healthy environment (ecosystems), and the economic benefits that flow from them, then we must act now to conserve native prairie and wildlife habitat. To lose any more will mean losing it all."

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REPTILES SESSION SUMMARY

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SESSION SUMMARY

The materials covered in this session were collected as labours of love. Any of the speakers could have used the entire time available. The audience was more than willing to listen and learn but there was little opportunity for session discussion. Since so few people knew anything about the species involved, this lack of discussion may have been appropriate for this first such session.

The reptiles considered (Short-horned Lizard [*Phrynosoma douglassi*], Prairie Rattlesnake [*Crotalus viridis*), Eastern Yellow-bellied Racer [*Coluber constrictor flaviventria*], Western Hognose Snake [*Heterodon nasicus*], and Northern Prairie Skink [*Eumeces s. septentrionalis*]) all face similar human development problems. All the species live in extremely small areas. Skinks and lizards may spend their entire lives only metres from their birth places. This survival technique has two major flaws when human developments are involved. First, disturbance or successional changes over small areas will result in population losses because local residents will not shift their territories. Secondly, roads, cultivation, irrigated farmlands, and access routes through their habitats will result in dividing the populations causing local extirpations. In either case, environmental changes will result in vacant habitats that will only slowly be recolonized.

Habitat management is essential for all reptile species considered if they are to remain in their traditional locations. Before management plans can be instituted, more information is needed on species biology and essential habitat needs. The effects of habitat disjunction, dispersal mechanisms, and reintroduction potentials all need to be clarified before management can be successful. For example, can grassland reptiles be successfully reintroduced? Are animals released outside their territories sentenced to death? Can habitat be created for these species?

Reproductive potential is very low for all species discussed. In the case of Prairie Rattlesnakes, females likely give birth every two or three years. All the species are vulnerable to vandalism because they are slow moving, concentrate at annually used locations at predictable times, and generally lack appreciation by humans. All are in decline and will require special consideration to maintain viable populations throughout their Canadian breeding ranges.

Speakers at the next workshop should be well aware that the purpose of the meeting is to discuss potentially effective management for the species involved and not to describe the biology of the animal. The number of speakers should be reduced or the session lengthened to accommodate the discussion aspect of the workshop. In the workshop interval, considerable data needs to be collected so that enough information is available for management discussions to be meaningful.

MONITORING SONGBIRDS IN THE PRAIRIE PROVINCES

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INTRODUCTION

There is an increasing body of evidence that long-distance migrant birds have declined (Askins et al. 1990, Gauthreaux 1990, Hussell et al. 1990, Robbins et al. 1989, Stewart 1987). Some point to deforestation in the tropics as the main factor in the decline (Morton 1980, Rappole et al. 1983, Briggs and Criswell 1986), others point to forest fragmentation on the breeding grounds with consequential increases in nest predation and cowbird parasitism (Lynch and Whitcomb 1978, Butcher et al. 1981, Brittingham and Temple 1983). Rappole and Powell (1986) and Terborgh (1989) argue that while the proximate problems may be on the breeding grounds, the ultimate limitation will soon switch to the wintering grounds. Diamond (1986, 1991) provides the only quantified estimates of losses through tropical deforestation of winter habitat to Canadian long-distance migrants.

A classical but outmoded concept is that forest wildlife are dependent on the forest for their existence, but that forests can exist without wildlife. Increasing evidence suggests, however, that forests and their wildlife are co-dependent and intricately inter-related as a result of a long co-evolution. One of the more striking examples of this co-dependence was postulated by Holling (1988), who suggested that tropical deforestation, the decline of long-distance migrant birds (those species that breed in temperate zones but winter in the tropics), and the recent "unexpected behaviour" of the Spruce Budworm (*Choristoneura furniferana*), particularly in eastern North America, may be related phenomena.

The connection between the decline of long-distance migrants and outbreaks of budworms is at present speculative, but surely warrants investigation. Under normal conditions, budworm outbreaks follow a cyclical pattern that is moderated to some extent by its predators. Holling suggested that when numbers of predators were reduced, the cycles would become more erratic; outbreaks would be more severe and occur more frequently. Holmes (1990) reviewed the impacts of bird predation on forest insects, and concluded that "birds...exert through their foraging activities important influences in (forest) communities on both ecological and evolutionary time scales."

It has long been known that songbirds are important predators on budworms. Some bird species are generalists which prey on budworms only opportunistically; others are specialists whose numbers and distribution appear to be directly related to budworm outbreaks. Among the specialists are several Paruline warblers, including the Tennessee (*Vermivora peregrina*), Cape May (*Dendroica tigrina*), and Bay-breasted Warblers (*D. castanea*) of the western boreal forest.

Recent evidence from Breeding Bird Surveys (BBS) from the eastern United States and Canada (as analyzed by Robbins et al. 1989) has shown that the numbers of many species of long-distance migrant birds have declined substantially between 1978 and 1987. Among the species whose numbers have declined the most severely are Bay-breasted (down by 15.8%, $p < 0.01$) and Tennessee Warblers (down by 11.6%, $p < 0.05$).

There has not yet been evidence of declines in long-distance migrants breeding in the forests of the prairie provinces. However, recent resurveys of forest bird monitoring plots near Doré Lake, Saskatchewan (Canadian Wildlife Service [CWS], unpublished data) (Table 1); and comparisons across several decades of numbers banded during fall migration through the prairies (Table 2), suggest strongly that the Tennessee Warbler has undergone a considerable reduction in its numbers in the western boreal forest. While numbers of Tennessee Warblers do fluctuate considerably in relation to Spruce Budworm cycles, budworm infestation was high in the Doré Lake area in 1990 and 1991, which should have led to high populations of Tennessee Warblers there, so the birds' decline is likely real. Population trends among forest songbirds may therefore prove to be of real economic interest to foresters, in addition to their implications for those charged with the conservation of migratory birds.

Table 1. Number of Tennessee Warbler Territories per 100 hectares on four plots surveyed at Doré Lake, Saskatchewan, 1973 and 1990/1991 (CWS, unpublished data). 1973 surveys by A.J. Erskine, 1990/1991 by P. Chytyk; both analyzed by D. Kirk.

Plot	Habitat Type/Location	1973	1990/91
1.	Mature Birch and Poplar Forest Michel point	80	2
2.	Balsam Fir Forest Appleby Bay, Sled Lake	63	46
3.	Black Spruce with Alder Swales Doré Lake Airstrip	74	46
4.	Young Aspen Forest Mirasty Lake	74	23
Average		73	29

The Role of Migration Monitoring Stations

Because relatively little study has been directed toward the details of migration in prairie neotropical migrants, and because only a coordinated research program which examines all phases of the migratory circuit can determine the stage or stages of the annual cycle during which declines may be taking place, it is essential that efforts be directed towards this phase of their life cycle, as much as to breeding and wintering biology and habitat needs.

Dawson (1990) pointed out that migration monitoring data "could be useful in corroborating trends estimated for species using data from the BBS or the Christmas Bird Count and in estimating trends for species that are not well sampled by these monitoring techniques." Hussell et al. (1990) have already shown a statistically significant correlation between BBS results for Ontario and the fall migration through Long Point. Migration monitoring may be the only way of censusing species such as the Blackpoll Warbler (*Dendroica striata*) and Gray-cheeked Thrush (*Catharus minimus*) whose breeding ranges lie in remote and uninhabited regions.

Dawson (1990) adds that "migration banding data offer two additional potential uses: 1) to monitor trends of adults returning from wintering grounds, and 2) to monitor trends in the number of adults and young surviving the breeding season. For species with declining populations, examination of trends from two seasons and for the two age classes might suggest whether the declines are associated with the breeding grounds or the wintering grounds."

While a number of migration monitoring stations (or bird observatories) have been established in eastern and southern North America, few exist in western Canada. Migration monitoring stations strategically located in western Canada may be our best option to

Table 2. Proportion of Tennessee Warblers in total wood warblers (Parulinae) banded in selected locations in Alberta and Saskatchewan.

	Nipawin, SK[1]	Edmonton, AB[2]	Beaverhill Lake, AB[3]	Last Mountain Lake, SK[4]
Years	1955-1960	1957-71	1980-89	1989-91
Tennessee Warblers	2031	1957	400	57
Total Warblers	2636	3455	3513	1935
%Tennessee Warblers	77	57	11	3

[1] Houston and Street 1959; [2] Salt 1973; [3] Jungkind 1989; [4] Smith unpubl. data.

monitor migrants breeding beyond the reach of the BBS and to confirm the results of BBS data.

Changes in the age structure of fall migrants might imply poor reproduction, while changes in the age and sex structure of spring migrants might indicate that on the wintering grounds there is sex or age-related segregation by geographic area or habitat, and that changes in habitat quality or quantity may be affecting age/sex ratios. Changes in physical condition of the birds might indicate changes in the quality of the breeding range (fall migrants) or wintering range (spring migrants).

Other related information from migrants can also be of value. Weight gains, for example, can indicate the flight ranges of the birds captured (see Nisbet et al. 1963, and below), or may reflect changes in quality of habitat at the migration stop-overs, and wing-lengths can shed light on the geographic origin of birds (Raveling 1965, Raveling and Warner 1978).

Another reason to study migrant songbirds is to improve knowledge of their migration physiology. Studies at Last Mountain Lake Bird Banding Station (Saskatchewan) have yielded new information on the importance of migration stopovers to migrating songbirds. In 1990, for example, we found that Blackpoll Warblers migrating through the Last Mountain Lake area remained for an average of 3.4 (± 1.0) days, and gained 0.44 (± 0.3) grams for each day they stayed. We know that a bird the size of a Blackpoll Warbler can fly one hour for each .08 g. of mass gained (Nisbet et al. 1963), and that their air speed is about 40 kph (22 knots). With the prevailing winds in the northern Great Plains often at 30 kph and often from the northwest, this translates into ground speeds of around 70 kph. Since Blackpoll Warblers at Last Mountain Lake gain on average 1.5 g while there, their next flight should last about 19 hours (1.5 g/.08 g per hour). A ground speed of 70 kph and a southeasterly flight path would take our Blackpoll Warblers some 1300 km and put them in the northern Illinois/southern Iowa area of the American Midwest. In still air, with a ground speed of 40 kph, they would fly about 760 km, reaching around the North Dakota - Minnesota border. This suggests that Last Mountain Lake is more than a mere rest stop but serves also as a refuelling station, at least for Blackpoll Warblers.

In summary, we suggest that monitoring migrant songbirds as they pass through the prairies can make a significant contribution to their conservation, by measuring annual productivity, and possibly survival and population trends as well, in addition to providing essential information on habitat needs of these birds on migration.

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SONGBIRD MIGRATION AT BEAVERHILL LAKE, 1980 TO 1991

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INTRODUCTION

With the present widespread concern over possible declines in neotropical migratory songbirds due to forest fragmentation and destruction on both breeding and wintering grounds, a network of songbird migration monitoring stations is being proposed for prairie Canada. This paper will present some of the banding results from 12 years of songbird migration monitoring at Beaverhill Lake in an effort to evaluate it's significance as a migratory songbird concentration or stopover site.

STUDY AREA DESCRIPTION

Beaverhill Lake is located about 70 km southeast of Edmonton, Alberta, in the aspen parkland zone. There are large areas of mature woodland 20 km west and northwest of the lake (Cooking Lake moraine uplands and Elk Island National Park) but most of the surrounding region, especially southeast is unwooded and primarily farmland. The lake is bordered to the south and east by strips of young aspen woodland, up to 12 m in height and extending up to 1 km in width, which grade through willow thickets to a strip of open grassland, about 25 to 150 m wide, adjacent to the lakeshore. Periodic flooding and spring melt water bring the lake up to the willow outskirts on occasion.

The Beaverhill Bird Observatory (BBO) Field Station is located 1 km west of a large bay at the southeast corner of the lake and 150 m south of the lakeshore. Net lanes (up to 30) are scattered among the edges and willow thickets interspersed with grassy openings. All lie within 100 m of the Field Station. Most of the net lanes are oriented north-south to intercept east-west movements of birds. Cattle grazing has been prohibited from this area since 1987.

DESCRIPTION OF ACTIVITIES

Bird banding at the BBO site was sporadic and minimal from 1980 to 1983, with two or three days of banding per season at most. With the creation of the BBO in 1984, there was more participation in the banding and a census route was set out. There were still large gaps however, in the banding and censusing activities in 1984 and 1985. From 1986 on, bird banding was maintained every year at a steady pace (at least once in each 10-day period) throughout the main spring and fall migrations. Summer field assistants participated in and expanded the banding and censusing activities in 1987 to 1990. In spite of this, overall effort in bird banding and censusing remained at a low level up until 1989 as manpower and energy were diverted to other more specific projects and activities. A MAPS (Monitoring Avian Productivity and Survivorship) station with constant effort mist netting (De Sante 1991) was set up on the site in 1989, continued in 1990 and 1991, to complement the migration monitoring.

Another individual, Edgar Jones (EJ), has banded with mist nets each year from 1980 to 1991. His capture method is to operate as many nets as possible, all day long for about a week at a time, up to four times a year, during peak spring and fall migration periods.

BANDING RESULTS

From 1980 to 1991, a total of 26,450 birds have been banded at Beaverhill Lake through the separate efforts of the BBO and EJ. At least 22,000 of these were "woodland" songbirds captured with mist nets. Although there were a lot fewer birds banded from 1980 to 1985 than from 1986 to 1991 at both the BBO's and EJs' sites, and there is no net-hour data available for 1980 to 1985, a comparison of the species percentages can give an indication of which species may have increased or decreased relative to the others. In order to eliminate the influences of non-woodland mist netting results, the comparisons in Table 1 are restricted to five major families of woodland passerines: flycatchers, chickadees, *Catharus* thrushes, vireos, and warblers. Capture totals for these species are:

BBO - 1980-85 - 563 birds banded, 24 sp.
1986-91 - 4381 birds banded, 34 sp.
EJ - 1980-85 - 2152 birds banded, 30 sp.
1986-91 - 8546 birds banded, 33 sp.

Table 1. Percentages of "woodland songbirds" banded from 1980 to 1991 at Beaverhill Lake by the Beaverhill Bird Observatory and Edgar Jones for 10 different species.

	Percentage of birds banded out of flycatchers, chickadees, *Catharus* thrushes, vireos, and warblers in the years:					
	1980-85		1986-91		Change in %	
Species	BBO	EJ	BBO	EJ	BBO	EJ
(Breeding)						
Traill's Flycatcher	4.4	2.7	3.9	2.8	-0.5	0.1
Least Flycatcher	35.7	23.2	27.3	25.6	-8.4	2.4
Black-capped Chickadee	18.1	13.1	6.5	5.5	-11.6	-7.6
Warbling Vireo	3.2	2.0	3.3	1.8	0.1	-0.2
Yellow Warbler	15.5	12.3	19.6	22.1	4.2	9.8
(Transient)						
Tennessee Warbler	1.2	5.1	8.6	3.7	7.3	-1.4
Yellow-rumped Warbler	13.3	30.9	16.5	30.8	3.2	-0.2
Blackpoll Warbler	1.1	1.3	1.7	1.3	0.6	0.0
American Redstart	0.2	1.7	4.0	0.8	3.9	-0.8
Wilson's Warbler	1.8	0.5	1.1	0.4	-0.7	-0.1
All other species from these five families	5.5	7.3	7.4	5.3	1.9	-2.0

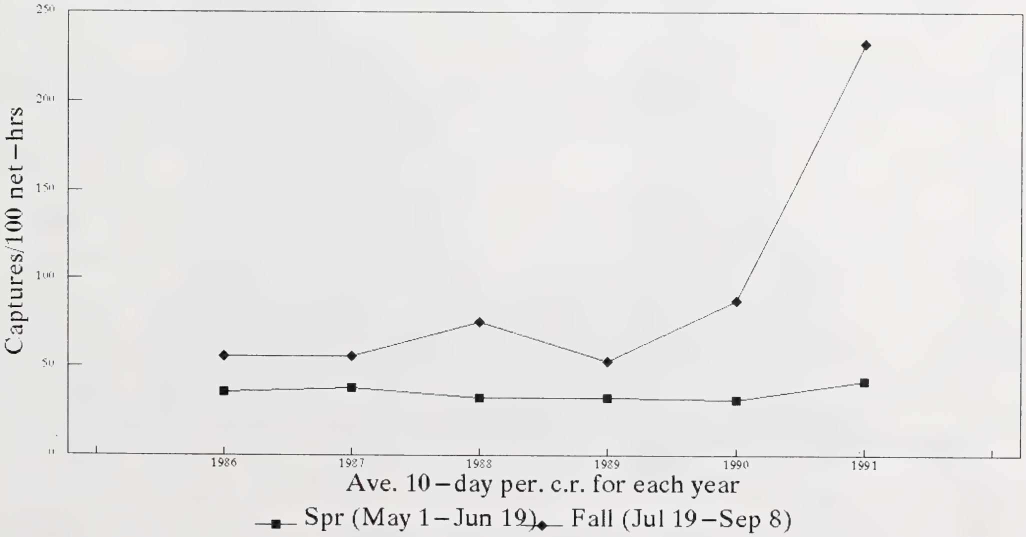


Figure 1. Average spring and fall ten-day period capture rates at the Beaverhill Bird Observatory for 1986 to 1991.

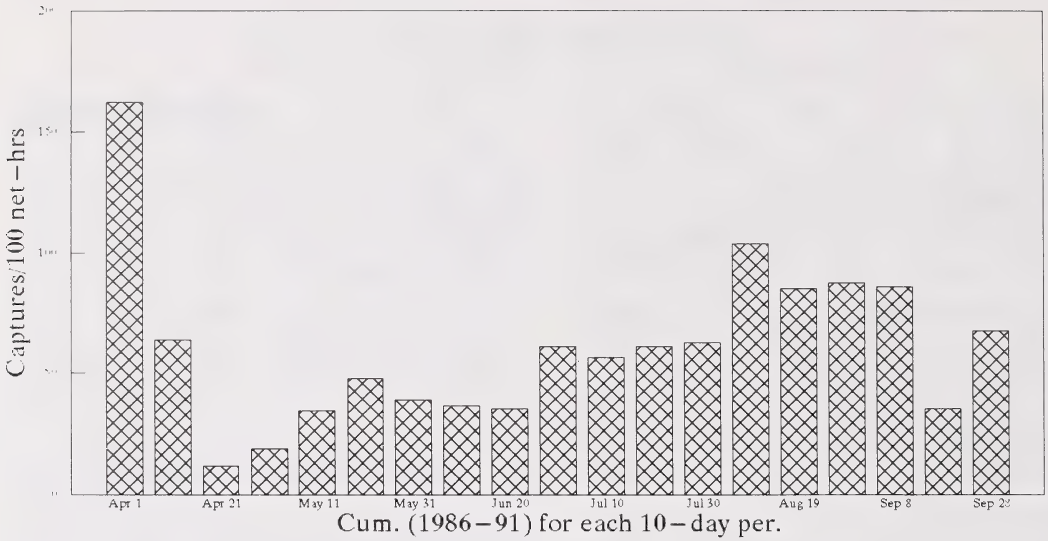


Figure 2. Ten-day period capture rates calculated over six years (1986 to 1991) for April 1 to October 7 at the Beaverhill Bird Observatory.

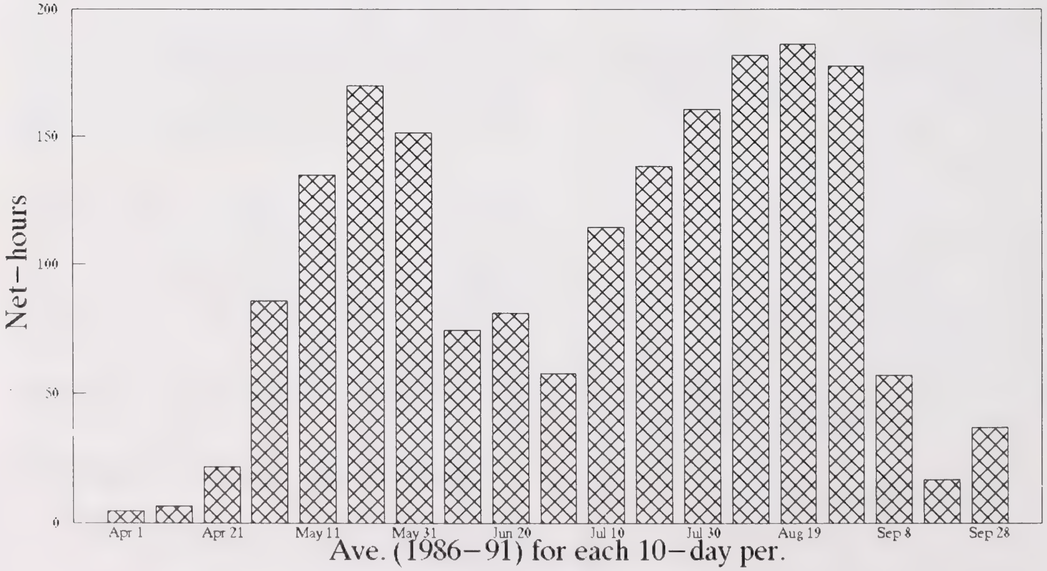


Figure 3. Average (1986 to 1991) ten-day period net hours at the Beaverhill Bird Observatory for April 1 to October 7.

These species make up 70% of the 22,000 woodland songbirds banded. The species selected for the comparisons were the five most banded breeding species and the five most banded transient species. It is interesting to note that while the percentages of four of the transient species of the BBO increased (three of them significantly), the percentages for those same species remained static or decreased in EJs' banding results. This is contrary to what one would expect since the BBO has increased its banding efforts during the breeding season while EJ continues to band only during spring and fall migration. It is possible that lack of grazing at the BBO site since 1987 has had a greater positive impact on transient species than breeding species. The Tennessee Warbler (*Vermivora peregrina*) increase at the BBO site (largest of all migration-only species) contrasts strongly with a major long-term decrease in Tennessee Warbler captures from EJs' bird banding activities in Edmonton prior to the mid 1980s (Jones 1986).

CAPTURE RATES FROM 1986 TO 1991

Since 1986, mist nets have been used at the BBO Field Station site for a total of 11,014.5 net hours (for 1988 to 1991, only "woodland" mist net hours have been included). This has resulted in 6645 captures, out of which 5800 birds of 71 woodland songbird species have been banded, including more than 1200 banded each year since 1989.

The large increases in the average 10-day period spring and fall capture rates from 1989 to 1991, are primarily due to extremely high 10-day period capture rates in August of both years (Figure 1). In 1991 in particular, extremely heavy migration on August 24 and 25 filled the nets to the point where five experienced banders could not keep up with the flood of birds in just two nets. A total of 250 birds were caught over the two mornings.

Mist netting effort has been quite good for the six year period. There are 20 possible mist netting periods (ten days each) between April 1 and October 7 each year. Eleven periods were identical for each of the six years (May 1 to June 19 and July 10 to August 28). In addition, five of six years saw the August 29 to September 8 mist netting period completed, four of six years saw the two periods between January 20 and July 9 completed, and three years of six saw the remaining six periods completed (April 1 to 30 and September 8 to October 7). It is apparent that with the exception of mid-September, maximum mist net effort has been during the most productive 10-day periods (Figure 2 and 3).

The yearly capture rate of 71 birds/100 net hour at the BBO in 1990 (1712.5 net hours and 1216 birds banded) compares favourably with the 66.2 birds/100 net hours recorded at Last Mountain Lake in 1990 (Smith 1991). The capture rate at the BBO for 1991 was 98.2 birds/100 net hours (1667.5 net hours and 1636 birds banded).

Table 2. Comparison between the Beaverhill Bird Observatory and Edgar Jones of capture rates and net hours for bird banding at Beaverhill Lake from 1988 to 1991.

	1988	1989	1990	1991	Average
Net hours					
BBO spr. (May 21-June 9)	273.25	446.6	167	369.68	314.1
EJ spring	1520	569	2896	1181	1541.5
BBO fall (July 21-Sept. 7)	565	1673.85	782.75	646.75	917.1
EJ fall	1686	2894	2223	1856	2164.8
Capture rate					
BBO spr. (May 21-June 9)	47.2	43.3	50.3	38.7	44.9
EJ spring	26.6	46.7	28.1	56.4	39.5
BBO fall (July 21-Sept. 7)	74.7	52.3	105.3	206.1	109.6
EJ fall	58.6	45.2	75.4	215.5	98.7

N.B. - BBO 1990 net hours and capture rate includes Sept. 18-27 to correspond to Edgar Jones' banding periods for that year

In order to compare capture rates to those of EJs' at Beaverhill Lake, it is necessary to restrict the comparison to the peak migration periods in spring (May 11 to June 9) and fall (July 20 to September 7), since those periods are when EJs' bird banding takes place. Both spring and fall peak period capture rates at the BBO are similar to those at EJs' sites (Table 2). The close parallel between the fall capture rates at the two sites over the four years suggest that whatever phenomenon created the huge increase in capture rate at the BBO is not site specific. Table 2 should also clarify why EJ catches so many more birds than the BBO each year—it is not because he is at a better location, but rather that he is able to accomplish more net-hours of mist netting during the most productive time of year.

CAPTURE RATES FOR INDIVIDUAL SPECIES

In order to make year-to-year capture rate comparisons meaningful for individual species, net hours have to be restricted to the 10-day periods during which the species occurs at Beaverhill Lake. This has been done for the same 10 species discussed earlier, using time frames derived from 12 years of sight records and banding data (Figure 4 and 5). All the species except Black-capped Chickadee (*Parus atricapillus*) and Blackpoll Warbler (*Dendroica striata*) had their highest capture rate in 1991, but this is most pronounced in the transient species—especially Yellow-rumped Warbler (*Dendroica coronata*), Tennessee Warbler, and American Redstart (*Setophaga ruticilla*). It is apparent that a large part of the 1990 and 1991 overall capture rate increases were due to the Yellow-rumped Warbler capture rate increases in those years.

RETRAPS

Gathering adequate retrap data on a species usually means there must first be a sufficient number of birds of that species banded. All but one (Swainson's Thrush [*Catharus ustulatus*]) of the top 20 species banded from woodland mist nets at the BBO from 1986 to 1991 have yielded retrap data of some sort (Table 3). The locally breeding species have all yielded "returns" at various percentages (Jungkind 1990, Campbell 1991) but the local nonbreeding species have only yielded one "return" in all the years of banding at the BBO—a Tennessee Warbler banded as after hatch year/male (HY/M) on August 17, 1989 was retrapped on August 27, 1990. However, with "repeats" there are enough records to start considering repeat percentages (Table 4) (see North American Bird Banding Manual for definition of "repeats" and "returns"). The length of stay for some of the locally nonbreeding species individuals certainly gives the impression that the BBO study area may be a major stopover site for songbirds on migration.

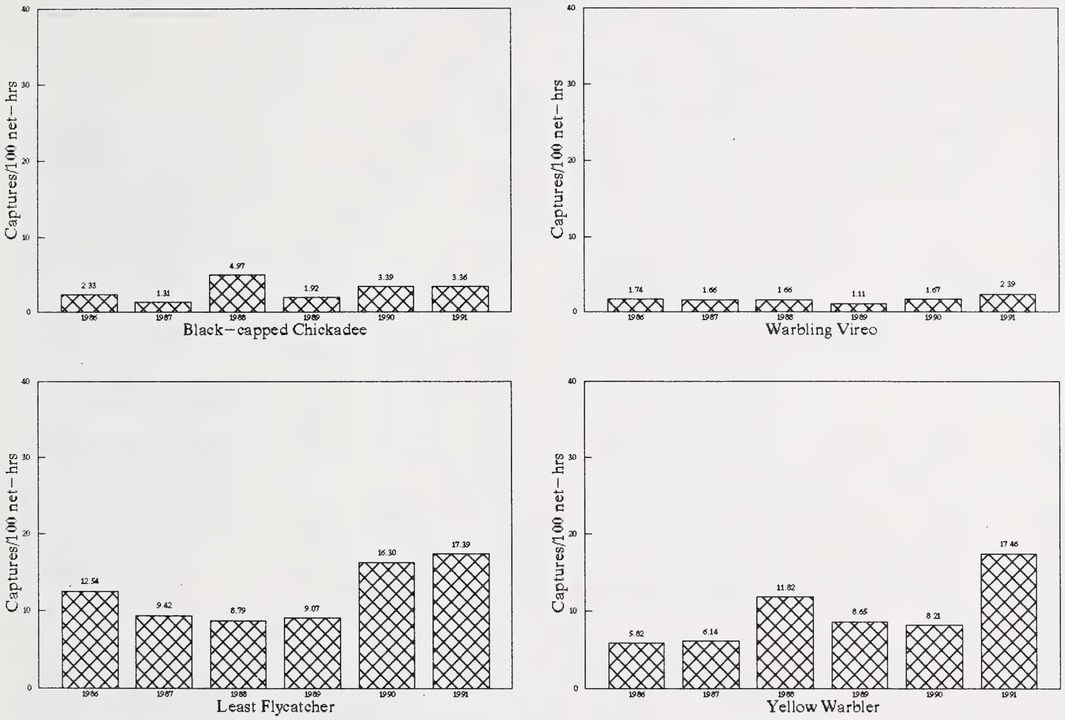
There have been 19 individual birds that were captured at both the BBO site and EJs' site—14 Yellow-rumped Warblers, 3 Least Flycatchers (*Empidonax minimus*), one Northern Oriole (*Icterus galbula*), and one Tennessee Warbler. It is interesting to note that all except two (both Yellow-rumped Warblers) of the locally breeding species individuals were caught in different years at the two sites, while all five of the locally nonbreeding species individuals were caught in the same season. The two HY/M Yellow-rumped Warblers that were banded at the BBO in August 1991 and recaptured four days later at EJs' site (about 8 km northeast) are particularly revealing. Perhaps the entire southeast corner and east shore of Beaverhill Lake is being used as a single stopover site by migrating songbirds.

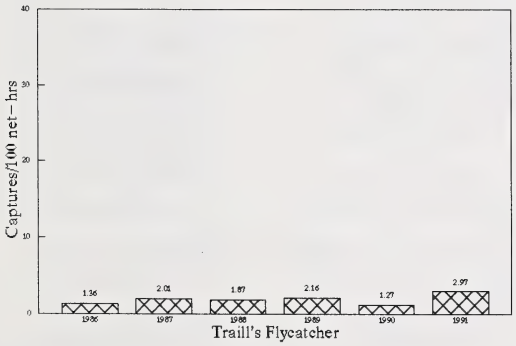
With 10,935 birds banded in total at the BBO since 1980 and only 11 recoveries, our recovery rate of 0.1% is not enviable. However, our only two long distance recoveries from woodland mist netting—a Least Flycatcher recovered in Guatemala and a Yellow-rumped Warbler recovered near Macon, Georgia—have already sparked additional interest and incentive to get more people involved in the bird banding program.

CONCLUSION

Although the data collected so far on songbird migration at Beaverhill Lake is not overwhelming in quantity, considering the length of time it has gone on, the capture rates and numbers of birds banded in 1990 and 1991 in particular seem to indicate that Beaverhill Lake and the BBO Field Station site may be a major songbird migration and stopover location in fall if not in spring also.

The strong points of the activities so far are: 1) six years of consistently spaced mist netting results for long stretches of the spring and fall migration, which will be valuable for comparisons to future years' data; 2) good, detailed experience gained regarding the effectiveness of the different net lanes under various weather conditions and different times of year; and 3) enough birds banded already that repeat, return and recovery data is starting to develop.

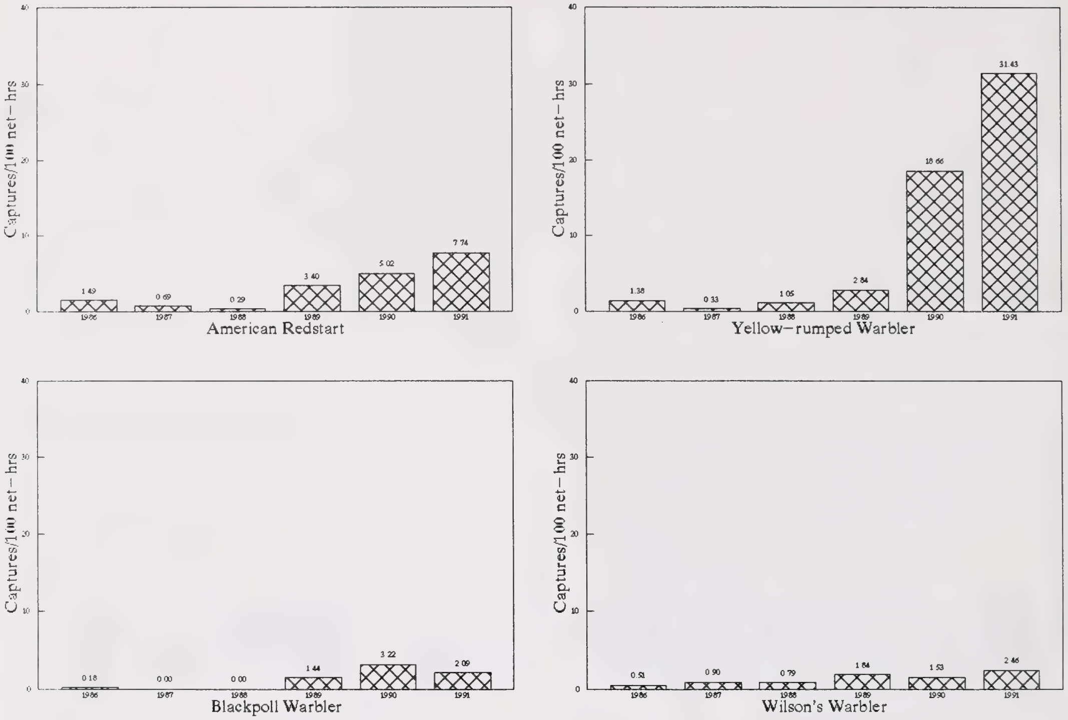


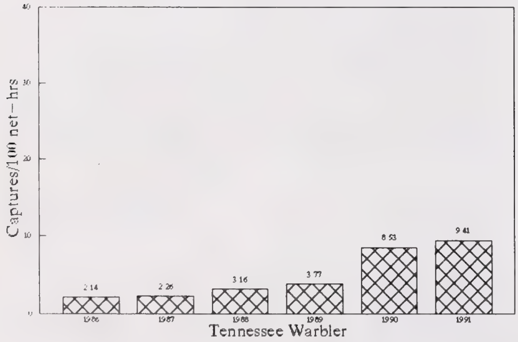


Time frames:

Black-capped Chickadee (*Parus atricapillus*)	April 1-Oct. 7
Least Flycatcher (*Empidonax minimus*)	May 11-Sept. 17
Traill's Flycatcher (*Empidonax* sp.)	May 21-Sept. 7
Warbling Vireo (*Vireo gilvus*)	May 21-Sept. 17
Yellow Warbler (*Dendroica petechia*)	May 11-Sept. 7

Figure 4. Capture rates from 1986 to 1991 for five breeding species at the Beaverhill Bird Observatory





Time frames:

American Redstart (*Setophaga ruticilla*)	May 21-June 9, Aug. 9-Sept. 27
Blackpoll Warbler (*Dendroica striata*)	May 21-June 19, Aug. 9-Sept. 17
Tennessee Warbler (*Vermivora peregrina*)	May 21-June 9, June 30-Sept. 7
Yellow-rumped Warbler (*Dendroica coronata*)	April 21-May 30, July 20-Oct. 7
Wilson's Warbler (*Wilsonia pusilla*)	Aug. 9-Sept. 17

Figure 5. Capture rates from 1986 to 1991 for five transient species at the Beaverhill Bird Observatory.

Table 3. Birds banded from woodland mist net captures at the Beaverhill Bird Observatory, 1986 to 1991 - top 20 species banded.

Species	1986	1987	1988	1989	1990	1991	Total 1986-91
Least Flycatcher (*Empidonax minimus*)	213	110	89	272	252	261	1197
Yellow Warbler (*Dendroica petechia*)	93	68	109	239	106	244	859
Yellow-rumped Warbler (*D. coronata*)	21	3	10	67	231	392	724
Clay-colored Sparrow (*Spizella pallida*)	53	34	37	71	115	194	504
Tennessee Warbler (*Vermivora peregrina*)	29	21	28	99	90	109	376
Black-capped Chickadee (*Parus atricapillus*)	40	17	57	60	53	57	284
American Redstart (*Setophaga ruticilla*)	16	5	2	52	45	57	177
Traill's Flycatcher (*Empidonax* sp.)	19	23	17	60	17	36	172
American Tree Sparrow (*Spizella arborea*)	28	8	31	15	42	40	164
Warbling Vireo (*Vireo gilvus*)	25	19	16	32	25	27	144
Red-winged Blackbird (*Agelaius phoeniceus*)	9	36	36	12	8	10	111
Blackpoll Warbler (*Dendroica striata*)	2	0	0	23	32	17	74
American Goldfinch (*Carduelis tristis*)	26	12	15	5	2	10	70
Savannah Sparrow (*Passerculus sandwichensis*)	11	8	19	15	7	9	69
Northern Oriole (*Icterus galbula*)	8	12	6	8	8	10	52
Brown-headed Cowbird (*Molothrus ater*)	13	0	5	16	9	8	51
Wilson's Warbler (*Wilsonia pusilla*)	4	3	3	19	11	9	49
Magnolia Warbler (*Dendroica magnolia*)	5	2	3	10	20	6	46
Red-eyed Vireo (*Vireo olivaceus*)	6	1	2	9	9	11	38
Swainson's Thrush (*Catharus ustulatus*)	4	0	1	25	2	3	35

Table 4. Repeat totals and percentages for 19 species banded at the Beaverhill Bird Observatory from 1986 to 1991.

	Total repeats 1986-91	Total banded 1986-91	Repeat %	Max. # of days	Length of stay (dates)
Downy Woodpecker (*Picoides pubescens*)	4	20	20.0		
Traill's Flycatcher (*Empidonax* sp.)	7	172	4.1		
Least Flycatcher (*E. minimus*)	82	1197	6.9		
Black-capped Chickadee (*Parus atricapillus*)	113	284	39.8		
Warbling Vireo (*Vireo gilvus*)	10	144	6.9		
Tennessee Warbler* (*Vermivora peregrina*)	14	376	3.7	34	July 20-Aug. 23, 1986
Yellow Warbler (*Dendroica petechia*)	98	859	11.4		
Magnolia Warbler* (*D. magnolia*)	1	46	2.2	2	Aug. 25-27, 1990
Cape May Warbler* (*D. tigrina*)	1	5	20.0	29	July 22-Aug. 20, 1989
Yellow-rumped Warbler* (*D. coronata*)	17	724	2.3	25	Aug. 6-31, 1991
Blackpoll Warbler* (*D. striata*)	2	74	2.7	1	Aug. 30-31, 1990
American Redstart* (*Setophaga ruticilla*)	3	177	1.7	2	Aug. 10-12, 1991
Wilson's Warbler* (*Wilsonia pusilla*)	1	49	2.0	3	Aug. 11-14, 1989
American Tree Sparrow* (*Spizella arborea*)	3	164	1.8	8	Sept. 28-Oct. 6, 1991
Clay-colored Sparrow (*S. pallida*)	43	504	8.5		
Savannah Sparrow (*Passerculus sandwichensis*)	1	69	1.4		
White-crowned Sparrow* (*Zonotrichia leucophrys*)	1	21	4.8	1	Sept. 4-5, 1988
Northern Oriole (*Icterus galbula*)	8	52	15.4		
American Goldfinch (*Carduelis tristis*)	11	70	15.7		

Average for non-breeding spp. (*) 4.6
Average for breeding spp. 13.0

The weak points are: 1) lack of consistent censusing to complement the banding program; 2) too few days of banding out of each 10-day period (usually only two or three) can result in many migration waves being missed; and 3) too wide a variety of data collection practices.

All these weaknesses have been and continue to be tackled, with big improvements showing in 1990 and 1991. Although volunteer effort continues to increase in quantity and quality, a systematic and rigorous approach seems feasible only with participation of employed personnel in the program.

Many questions have arisen while compiling the data presented in this paper: Why the increased capture rates? Is there a connection between transient species increases and lack of grazing? What are directions and destinations of the songbirds passing through? Why are some of them staying so long—moult? putting on fat, etc.? These questions leave us with a great desire to encourage increased quality and quantity of the songbird migration monitoring at the BBO Field Station to the point where there will be a fully operational daily banding and censusing program maintained at the site throughout spring and fall.

ACKNOWLEDGMENTS

I wish to thank all the volunteers and field assistants who put in time, effort, and dedication to collect the data presented in this paper, with a special thanks to Rainer Ebel, Jim Faragini, and Geoff Holroyd. Jim Faragini also assisted with inputting data on computer files, as did field assistants Shannon Lord and Petra Stubbs. Special thanks to Dave Prescott and Leslie Beattie whose donation of a computer to the BBO in 1990 made the compilation of data possible and to Alan Hingston and Helen Schiebel who assisted with printing the graphs. Petra Stubbs and Geoff Holroyd made valuable suggestions on the rough draft, and my wife Debra Belmonte lent support and assistance during both the data collection and compiling process. Lastly, I wish to thank Edgar Jones for his willingness to pass on to me his bird banding summaries and capture rate data for the past four years.

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PATTERNS OF MIGRATION OF WARBLERS THROUGH THE DUNE-RIDGE FOREST, DELTA MARSH, 1982 TO 1984: THE NEED FOR A SECOND LOOK

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SUMMARY

Timing of fall migration and patterns of moult of warblers moving through the dune ridge forest at Delta Marsh, Manitoba, were monitored by den Haan and Sealy during 1982 to 1984. Mist netting was conducted almost daily from early June to September and three to five days/week until mid October on a 0.3 km section of the ridge forest, primarily west of the University of Manitoba Field Station (Delta Marsh) on the south shore of Lake Winnipeg in Manitoba. Warblers were aged by "skulling"; permitting hatch year (HY) and after HY designations prior to about mid September. At the end of September, any birds not definitely determined as HY were classified as birds of unknown age (U) because "early season" HY's may have acquired fully-ossified skulls by this time.

During 8,868.1 net hours (July 1 to October 30), 2345 warblers representing 21 species were banded for an overall capture rate of 26.4 warblers per 100 net hours. Tennessee Warblers (*Vermivora peregrina*) were most numerous (n = 607) followed by Yellow-rumped Warblers (*Dendroica coronata*, n = 606), Northern Waterthrush (*Seiurus noveboracensis*, n = 234), American Redstart (*Setophaga ruticilla*, n = 196), Ovenbird (*Seiurus aurocapillus*, n = 134), Orange-crowned Warbler (*Vermivora celata*, n = 93), Blackpoll Warbler (*Dendroica striata*, n = 74), Black-and-white Warbler (*Mniotilta varia*, n = 63), and Nashville Warbler (*Vermivora ruficapilla*). For each of these species, we determined, using contingency analysis based on periods appropriate for each species, how catch rate (captures per net-hour) and age compositions changed over the three years of the study. Significant increases in populations of Tennessee, Nashville, and Yellow-rumped Warblers, Ovenbird, Northern Waterthrush, and American Redstart were found in 1983 compared to 1982 and 1984. A significant increase in the proportion of HYs was found also in 1983 for Tennessee Warblers.

Other species captured were Canada (*Wilsonia canadensis*, n = 44), Connecticut (*Oporornis agilis*, n = 36), Magnolia (*Dendroica magnolia*, n = 35), Palm (*D. palmarum*, n = 33), Mourning (*Oporornis philadelphia*, n = 25), Wilson's (*Wilsonia pusilla*, n = 22), Bay-breasted (*Dendroica castanea*, n = 13), Cape May (*D. tigrina*, n = 8), Chestnut-sided (*D. pensylvanica*, n = 5), Blackburnian (*D. fusca*, n = 3), Black-throated Blue (*D. caerulescens*, n = 1), and Black-throated Green Warblers (*D. virens*, n = 1).

The dune ridge forest study site is a valuable monitoring location for warblers and other neotropical migrants. Our historical data for this site provides a unique opportunity to compare relative populations of these birds through time. This is particularly relevant in light of reported declines in these species throughout North America. A minimum of three years of continued monitoring, using methodology identical to that used during 1982 to 1984, is recommended for the period 1992 to 1994.

STATUS OF THE INTERIOR CANADA TRUMPETER SWAN SUBPOPULATION

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INTRODUCTION

During the last 90 years Trumpeter Swans (*Cygnus buccinator*) breeding in western Canada have made a dramatic comeback. From a small remnant flock of less than 100 swans, there are believed to presently be about 1800 to 2000 trumpeters summering in Canada. Although the proportion of Trumpeter Swans breeding in Canada is still small (13%) relative to the total North American population, and breeding flocks are limited to a small portion of western Canada, it is now classified as a vulnerable migratory bird by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Major management concerns are related to the concentration of breeding and wintering habitats in western North America. In order to determine population status and breeding habitat use, surveys of over 15 separate flocks (Figure 1) in western Canada have been conducted every five years in five provincial jurisdictions. This presentation will review the population status and management concerns related to Trumpeter Swans breeding in Canada.

1990 SURVEY RESULTS

The last range-wide survey of the Interior Canada Subpopulation (ICSP) was conducted in 1990 (McKelvey and Hawkings 1990, Shandruk 1990); detected considerable change and growth since 1985. In the Yukon three major flocks (Itsi, Teslin, and Toobally) were surveyed. The total flock size went from 125 in 1985 to 209 swans in 1990 (Figure 2). This was a 65% increase from 1985 and an annual growth rate "r" of 10.6%. In the Northwest Territories Trumpeter Swans were surveyed in the southwestern Mackenzie District centred around Nahanni National Park Reserve (NNPR), this flock increased from 75 in 1985 to 182 in 1990 this was an increase of 129% with an annual growth rate of 18%. In British Columbia three major flocks (Fort Nelson, Fort St. John, and Dawson Creek) were surveyed. The total flock size went from 108 to 294 in 1990. This was an increase of 172% from 1985 and a calculated annual growth rate of 22%. This exceptional growth rate for the British Columbia flock may be due to an under estimation of the 1985 flock size. In Alberta five major and three small flocks were surveyed. In general, Alberta flocks increased through the mid-1980s. Grande Prairie has remained relatively stable since then, due in part to winter mortality, spring flooding with consequent poor production, removal of swans to Elk Island National Park (EINP), and possibly immigration to other areas. Several of the smaller flocks have grown significantly since 1985, leading to an overall increase in Alberta's total flock size from 334 observed in 1985 to 477 in 1990. This is a 43% increase in the total population over the five year period and an annual growth rate of 7%. In Saskatchewan only the Cypress Hills flock was

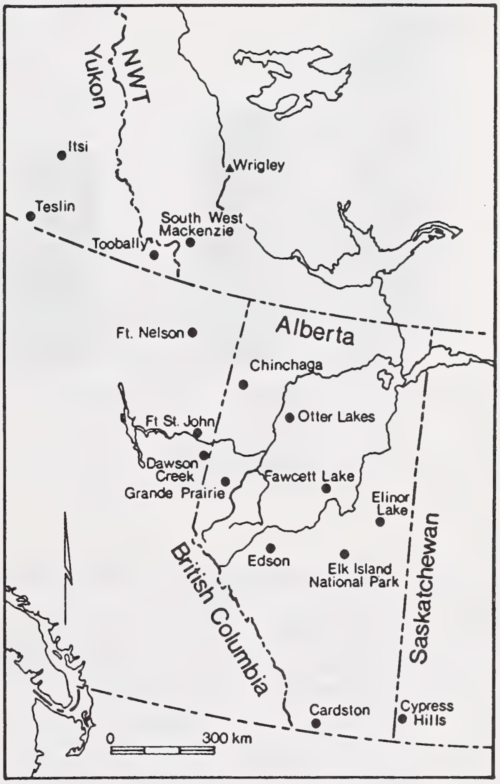

Figure 1. Location of Interior Canada Subpopulation Flocks, 1990.

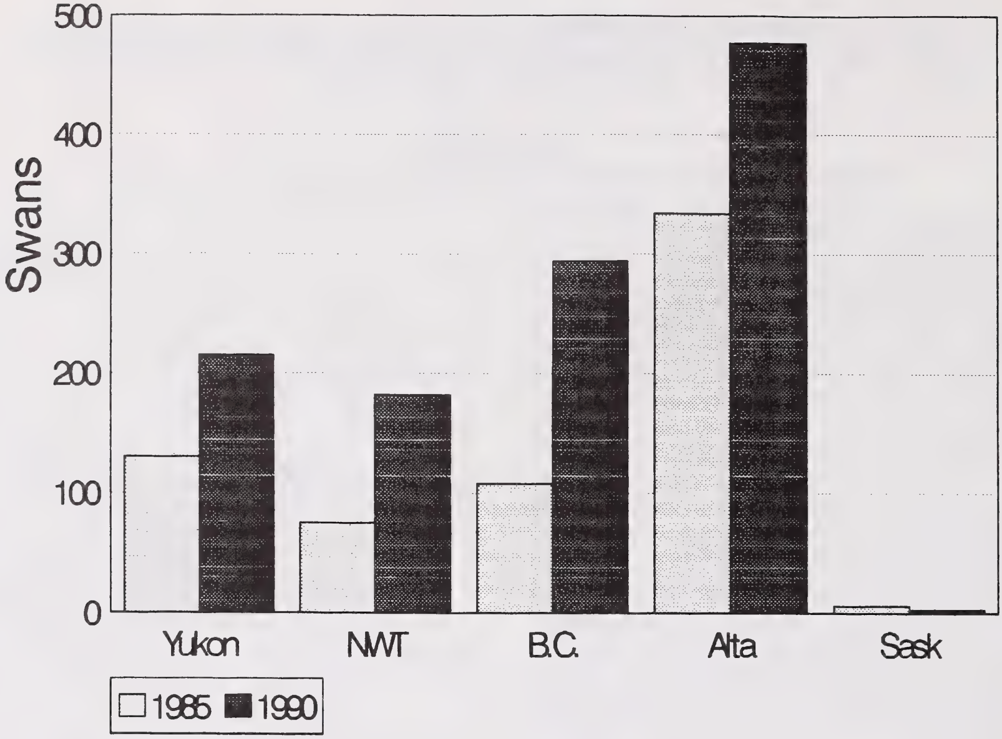

Figure 2. Flock Growth by Province 1985-1990.

surveyed and it continues to decline, with only three trumpeters recorded in 1990 and six in 1985. Without management intervention it will probably not exist in 1995.

Overall within the ICSP total white birds (adults and subadults) increased from 462 in 1985 to 791 in 1990. Cygnet production has increased from 191 in 1985 to 380 in 1990. The total ICSP increased from 653 Trumpeter Swans censused in 1985 to 1171 in 1990, a 79% increase. The results of the 1990 survey also indicate that over the five year period paired swans increased by 82%, flocked swans by 54%, cygnets by 99%, singles by 40%, and broods by 100% (Figure 3). This was an overall growth rate (r) of 12.4% per year. Mean brood size did not show a substantial change going from 3.2 to 3.3 cygnets/brood. The overall productivity for the ICSP (cygnets/total swans) did increase from 29.4% in 1985 to 32.5% in 1990.

EINP

This area was chosen for an experimental program designed to reintroduce an additional breeding flock within historic range, diversify migration patterns, and possibly expand winter range.

In 1987, eight adults and 18 cygnets were relocated from Grand Prairie. Eight adults and 20 cygnets were moved in 1988, followed by 10 adults and 20 cygnets in 1989. In 1990, two adults and 14 cygnets were relocated. In 1991, three adults and four cygnets were relocated from the Grande Prairie area. In addition, four captive reared yearlings were released at EINP.

Winter mortality of relocated trumpeter cygnets has been found to be exceptionally high. Several of the swans transplanted to EINP were observed wintering away from traditional sites in the Tri-state region. At present, five adults are summering at or in the vicinity of the park. Breeding of one pair occurred in 1990 which produced two cygnets which did not fledge.

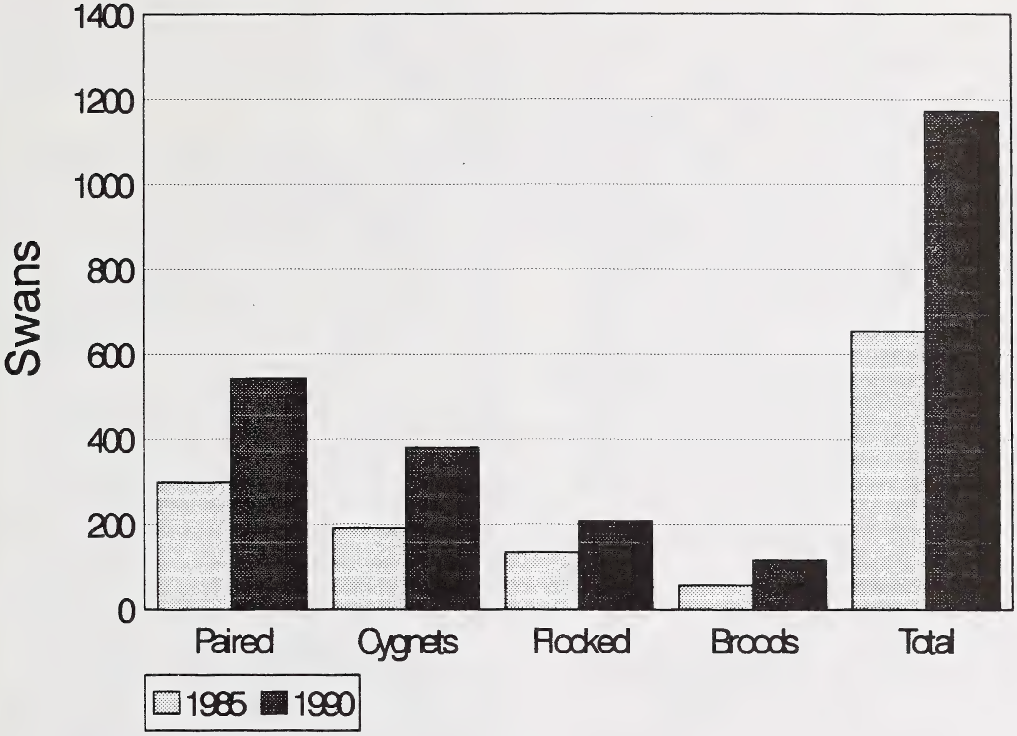

Figure 3. ICSP Flock Component Changes 1985-1990.

The cob of this breeding pair was an original 1987 transplant cygnet, while the female was of unknown origin. But in order for this transplant to succeed, survival and recruitment of relocated trumpeters must be increased.

MIGRATION AND WINTERING

Most of what is known about migrating Canadian Trumpeter Swans comes from observations of birds marked in summer range in Northwest Territories and Alberta, or on winter range in the Tri-state area (Figure 4). Swans begin to leave the northern breeding range in October. Most arrive at various Tri-state wintering sites in late October or early November. Gale et al. (1987) provides a comprehensive review on arrival dates and movements of ICSP swans in the Tri-state area.

Sightings of collared trumpeters during fall migration are somewhat limited. Red collars have been observed at Grande Prairie, at Waterton Lakes National Park, and along the east slope of the Rockies in several locations in Alberta. A red collared swan was observed near Cour d'Alene, Idaho on November 27, 1987.

Most of the swans collared in Alberta winter on or near Yellowstone Lake and River, and Henry's Fork of the Snake River in Idaho. The use of the Henry's Fork with crowded conditions, uncertain access to forage, and extreme winter weather may be impacting ICSP flock growth. Swans migrating from EINP have been seen at numerous winter sites. There are November sightings from Hebgen Lake, Montana; Teton River, Idaho; and Snake River near Rexburg, Idaho; and January sightings from Grand Teton National Park, Wyoming (Shandruk and Winkler 1988). Marked EINP swans have been seen every month from November through April at Red Rock Lakes National Wildlife Refuge (RRLNWR), Montana.

Most swans collared in Northwest Territories appear to winter in the Teton Basin of Idaho. Northwest Territories swans have also been sighted at Wells and

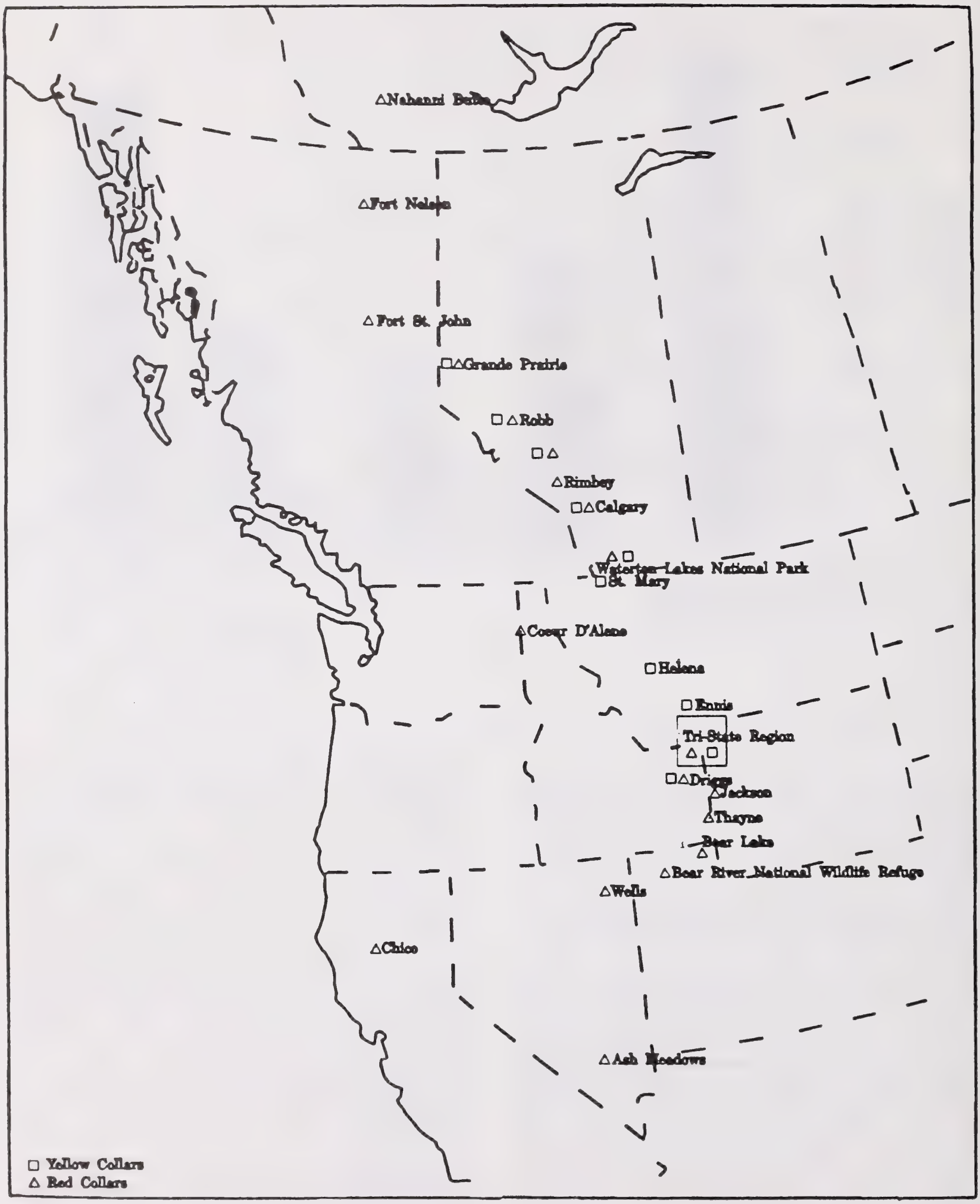

Figure 4. Canadian Collar Observations 1987-1990.

Ash Meadows, Nevada; south central Oregon, and Chico, California.

Trumpeters (green collars) marked during the winter of 1990/1991 have provided considerable information on spring staging and migration. Swans stage at RRLNWR and Ennis Lake, Montana in February and March. Swans enroute to Canada have been observed in Montana at RRLNWR, Ennis Lake, Lake Helena, and Freezeout Lake. Another smaller migratory route apparently runs from the Tri-state region up the Clark Fork, Bitterroot, and Flathead valleys, with marked swans observed at Warm Springs Wildlife Management Area, Lee Metcalf National Wildlife Refuge, and near Fortine, Montana. In Canada, a majority of green collars were observed in the Cardston-Mountain View area and along the east slopes of the Rockies in Alberta and British Columbia. Scattered sightings also occurred in the Columbia Trench on the west side of the Rockies in Kootenay National Park, British Columbia and the Yukon Territory. Summering green collar trumpeters were observed at Mountain View, Alberta; Rocky Mountain House, Alberta; EINP, Alberta; Edson, Alberta; Grande Prairie, Alberta; Peace River, Alberta; Stoney Lake, British Columbia; and in the NNPR in the Northwest Territories.

MANAGEMENT CONCERNS

It is obvious that the ICSP continues to grow and expand it's breeding range. This growth and expansion has been particularly evident in the northern flocks of the Yukon, Northwest Territories, and British Columbia. In the southern portion of its range, the growth of the ICSP (especially the Grande Prairie flock) has not been as vigorous. Collar observations have indicated that Grande Prairie trumpeters may be major occupants of the over crowded wintering habitats centred on the Henry's Fork of the Snake River. Whereas collar observations of Northwest Territories trumpeters indicate that these birds are more diverse in their choice and use of wintering habitats. This lack of specific dependence upon the Henry's Fork may have enabled the more northern flocks to continue to grow while the southern flocks (Grande Prairie) have begun to show signs of reaching the saturation point of their current wintering areas. Thus there is an urgent need to expand and diversify the current wintering range of the ICSP. Should this not be accomplished immediately, we may lose or reduce the growth of a substantial portion of Trumpeter Swans breeding in Canada. In addition, the growth of the ICSP and their over utilization of the winter habitat is having a negative impact on the growth of the non-migratory Tri-state subpopulation.

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TRUMPETER SWAN SESSION DISCUSSION

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Dale Hjertaas briefly recounted the discovery of a breeding pair of Trumpeter Swans (*Olor buccinator*) near Greenwater Provincial Park in east-central Saskatchewan, bringing the provincial population to two pair. Recent reports from trappers suggest the presence of at least one additional pair in this area. The one pair was collared in 1991 and tracked to the winter area at La Creek National Wildlife Refuge in South Dakota.

Saskatchewan would like to build on this new migration route to develop a migratory population which winters somewhere other than in the crowded Tri-state wintering area. However, managers at La Creek are concerned about over crowding there during the winter and are thus reluctant to see an increased population migrate to La Creek. They apparently wish to encourage some of their swans to migrate further south.

In discussion, the following significant points were raised:

1. All restored populations including those in South Dakota, Minnesota, Michigan, and Wisconsin depend on artificial feeding for their survival.

2. There is concern that many potential over wintering areas are too contaminated with lead shot for use by Trumpeter Swans.

3. Some years ago about 20 juvenile swans were allowed to fly free from their breeding pen at Delta. Some of these swans migrated and returned, the wintering area is not known.

4. The La Creek birds came from Redrock Lake where swans are resident but where migrants also winter.

5. Conflict with hunting seasons on Tundra Swans (*Cygnus columbianus*) in North Dakota is another concern about releasing swans in Saskatchewan.

6. Manitoba is interested in establishing a Trumpeter Swan breeding population, possibly in eastern Manitoba where they would migrate down the Mississippi Flyway and avoid areas of Tundra Swan hunting.

The following suggestions and recommendations were recorded during the session. While not necessarily indicating a consensus there was at least some agreement that these were approaches that should be pursued for Trumpeter Swan restoration in Manitoba and Saskatchewan.

1. Manitoba and Saskatchewan should prepare a joint proposal for swan reintroduction to ensure programs are compatible, show the Americans we are integrated and to work together instead of in competition when seeking sources of birds for release.

2. The winter crowding at La Creek might be dealt with in conjunction with a Saskatchewan release to build on the Greenwater pair. A combination of resource reduction by delaying start up of winter feeding and hazing timed for immediately after the Saskatchewan birds arrive might stimulate the migrants to continue further south. If the pressure at La Creek was substantial they might take some local swans with them. The key would be to reduce the quality of the habitat at La Creek at the appropriate time.

3. To initiate a release where there are currently no Trumpeter Swans, as in Manitoba, it might be possible to just let cygnets go. The one release at Delta suggests that at least some of them will migrate and return, as Canada Geese do. This would leave the young swans to choose their own wintering area but perhaps they understand habitat better than we do anyway.

4. Should ensure that any introduction proposal will produce a self-sustaining population and not one which required continual support.

5. It might be possible to get Trumpeter Swans to migrate with Tundra Swans and so move to safe winter areas.

6. Cygnets from La Creek might be transferred north to build the Greenwater population. They would then migrate back to La Creek. This would have two advantages. It would build the Greenwater population without a net gain in the number at La Creek while increasing the portion of La Creek birds with a tendency to migrate and thus possible move further south.

STATUS OF FERRUGINOUS HAWK AND LOGGERHEAD SHRIKE RECOVERY EFFORTS.

Ken D. de Smet

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This presentation will discuss the current status of national recovery plans for the Ferruginous Hawk (*Buteo regalis*) (Schmutz et al. 1990) and the Loggerhead Shrike (*Lanius ludovicianus*) (Telfer 1990), and will outline recovery objectives and regional conservation initiatives. Although measures are being undertaken in each of the prairie provinces, this presentation will focus on conservation efforts and research in Manitoba (within the zone of intergradation between western and eastern subspecies of the Loggerhead Shrike and on the northeastern edge of the breeding range of the Ferruginous Hawk).

FERRUGINOUS HAWK

The Ferruginous Hawk was officially listed as a "threatened" species in Canada during the early 1980s because of substantial reductions in its breeding range and because the species is a food and habitat specialist. Since the Ferruginous Hawk is both a top level predator and a specialist, it is an ideal bio-indicator of the health of prairie ecosystems.

The Ferruginous Hawk National Recovery Team has met on an annual basis to revise the national recovery plan, to priorize national recovery strategies, and to discuss regional management initiatives and future work plans. The national recovery plan lists six recovery actions and priorizes these. The top priority action is to maintain prairie grasslands. Priority II actions include maintaining an adequate prey base for nesting populations, managing nest sites, and perpetuating adequate winter habitat. Priority III actions include preventing human disturbance and shooting, and continued population monitoring. It should be noted that this recovery plan is dynamic (i.e., directions and priorities change over time and as the species responds to conservation actions) and that regional priorities may differ from those presented in the national plan.

The top priority for recovery of Ferruginous Hawks is the maintenance of prairie grasslands (Schmutz et al. 1990). This includes: 1) identifying key nesting habitat and critical areas; 2) managing grasslands for the benefit of Ferruginous Hawks; and 3) conserving existing grasslands.

Conservation of existing grasslands can be accomplished by: 1) encouraging grazing as a sustainable land use; 2) discouraging production of cereal crops on marginal lands; 3) providing incentives to maintain grassland areas; 4) encouraging voluntary stewardship of critical habitats; 5) reinforcing policies that discourage further conversion of public grasslands to cropland; and 6) increasing public awareness of the importance of grassland habitat.

A variety of federal, provincial, municipal, and non-governmental programs include initiatives for land conservation (i.e., the Permanent Cover Program, Farming for Tomorrow, Conservation District initiatives, Prairie CARE [Conservation of Agriculture Resources and the Environment], etc.). Most of these programs subsidize landowners to take marginal lands out of cultivation, to convert cultivated acreage back to forage, or to plant shelterbelts. Since 1987, many critical areas for threatened grassland birds in southwestern Manitoba have been leased or voluntarily protected through cooperative agreements between landowners and the Habitat Heritage Corporation (or its successor, the Critical Wildlife Habitat Program). In 1991 alone, over 2000 acres were protected through this program. The 1991 Threatened Grassland Birds report (de Smet, in prep.) lists other critical areas for these species, including 20 key areas (portions of 70 townships) with suitable habitat to support Ferruginous Hawks.

Maintenance of an adequate prey base essentially involves management of ground squirrel populations. This can be accomplished through: 1) encouraging grazing as a sustainable land use; 2) promoting an understanding of the value and role of ground squirrels; 3) ensuring that poisoning programs do not severely deplete ground squirrel availability in nesting areas; and 4) gaining a better understanding about the basic biology of ground squirrels and alternate prey sources.

Ground squirrels generally comprise more than three-fourths of the diet of Ferruginous Hawks. Alternate prey items include hares or rabbits (in some western states, they are the primary prey) and Northern Pocket Gophers (*Thomomys talpoides*) (in 1988, one-third of the food remains in Manitoba nests were Northern Pocket Gophers). Promoting the value of ground squirrels to landowners can be a little risky, particularly after these landowners have been overrun with "gophers" as in recent years. Nevertheless, maintenance of ground squirrels may be critical to the survival of Ferruginous Hawks and some other threatened prairie residents (i.e., the Burrowing Owl [*Athene cunicularia*] and Long-tailed Weasel [*Mustela frenata*]).

Management of nest sites includes: 1) locating nests and identifying their conservation needs; 2) encouraging landowners to develop and protect nest sites; 3) fencing used or potential nest sites; 4) planting trees and shelterbelts to create future nest sites; and 5) constructing artificial nests where possible.

Extensive use of artificial nesting structures by Ferruginous Hawks has been one of the most encouraging developments in Manitoba. Grasslands in Manitoba are rarely devoid of trees (as is the case in many potential nesting areas in Alberta and Saskatchewan). Nevertheless, nesting can be encouraged in some areas that are currently unoccupied by situating artificial nest structures in suitable sites. In other areas, nest success can be enhanced by placing structures in more stable trees or in remote locations. Many nests are blown down each year by strong winds. Of 56 nests used in 1990, for example, nearly one quarter had blown down before the 1991 season. Three others were used by Great Horned Owls (*Bubo virginianus*) and two by Red-tailed Hawks (*Buteo jamaicensis*). These Ferruginous Hawk pairs require alternate nests or they will be forced to seek new nesting territories. Data on Manitoba nests reveals that higher nests are generally more successful; 59 nests 8 m in height have produced an average of 2.0 young/initiated nest, compared to 1.6 young/nest for 5 m to 8 m nests (n = 57) and 1.2 young/nest for 59 nests that were lower than 5 m. Since human disturbance often results in abandonment or loss of lower nests, more than half of the 1991 structures were situated at heights of 9 m (30 feet) or more and few were placed lower than 6 m (20 feet).

Two hundred artificial nest structures have been erected in Manitoba since 1987. Although only 12 were used during 1991, this represented one-quarter of the nesting population. Structures that have been provided include a number of wooden platforms, existing magpie or smaller nests that were modified and added onto, and nests that were built from scratch using sticks. Most of the structures in 1990 and 1991 consisted of a basket made from 2 inch stucco wire and filled with sticks. As in the past, these were situated: 1) in a major fork of a tree (generally about two-thirds of the way up); 2) in sturdy trees or branches (often in cottonwoods); 3) in isolated situations (well removed from yards and roads and preferably removed from nearby trees or shrubs); 4) near or within good hunting pastures (with abundant ground squirrels); and 5) in areas where Ferruginous Hawks have previously been seen. Branches are cleared from around the structure and abundant stick material is added to make it more attractive to Ferruginous Hawks and less attractive to other raptors.

Perpetuation of adequate winter habitat presents a management challenge since wintering birds are usually associated with prairie dog (*Cynomys* spp.) colonies. The recovery plan calls for: 1) additional studies of their winter feeding ecology and alternate prey; 2) encouragement of prairie dog management in the winter range; and 3) a Canada - United States - Mexico agreement to manage its habitat and prey.

To facilitate this, the Recovery Team has proposed that a representative from Texas and Mexico be asked to participate in future meetings.

Preventing human disturbance at nests is important since Ferruginous Hawks are among the most sensitive of raptors to disturbance. One visit to the nest before or during egg-laying will usually result in the pair abandoning the site; some pairs will even abandon nests when they have small young or if a curious observer lingers near the nest tree. Although public attitudes towards raptors are more enlightened than in the past, shooting losses still occur. Disturbance and shooting can be discouraged by: 1) providing information guidelines to industry, recreational users, and landowners; 2) encouraging enforcement of existing laws; 3) fostering a positive public attitude; and 4) working towards additional protection on the winter range.

Regarding landowner awareness, it never hurts to point out that Ferruginous Hawks are a threatened species and that a single pair and their young can take 500 ground squirrels in a nesting season.

Recovery of the Ferruginous Hawk also calls for continued population monitoring at certain sites, including: 1) periodic reevaluation of species status (prairie-wide inventories should be conducted at 5-year intervals); 2) encouraging ongoing monitoring in selected study sites; 3) facilitating maximum use of the data collected (by collecting compatible data in all jurisdictions); and 4) monitoring population dynamics (i.e., natal site fidelity, productivity, limiting factors, mortality and survival rates, recruitment, etc.).

Populations declined throughout the prairies in 1991. Manitoba's population declined for the first time since monitoring began in 1987 (from 56 to 48 pairs—a 14% drop). This was not as severe as declines in the Hanna, Alberta study area (Joe Schmutz pers. comm.) and in Saskatchewan (Stuart Houston pers. comm.); in both areas, a drop-off in ground squirrel numbers may have contributed to declines and lowered productivity. A prairie-wide census of Ferruginous Hawks is slated for 1992; the current suspicion is that populations are returning to more normal levels after several years where drought and abundant ground squirrels contributed to elevated populations on the prairies. The Recovery Plan recommends that the species' status be reviewed in 1997; the species may be down-listed at that time if populations remain stable. Delisting is recommended if key habitats and nest sites are secure, and if populations remain above target levels (2500 pairs in the prairies including at least 100 pairs in Manitoba, 800 in Saskatchewan, and 1400 in Alberta).

LOGGERHEAD SHRIKE

The current status, limiting factors, and recovery objectives for the Loggerhead Shrike are not as clear. Numbers of this species have been declining and its range shrinking across North America. Such widespread and uniform declines without apparent cause are rare and have prompted concern from jurisdictions throughout its range. In Canada, the species was declared threatened during the mid-1980s and a recent status report recommended an endangered status for the eastern subspecies (which nests from southeastern Manitoba to Québec).

Loggerhead Shrikes prefer grassland sites, often heavily grazed or mowed. They also require shrubs and trees for nesting and for hunting perches (although utility wires and fences are preferred hunting perches, where available). Some populations thrive in areas where few grasslands remain. Manitoba's densest nesting populations occur in shelterbelt-dominated townships near Lyleton in the extreme southwest. Territories in this area are dominated by cropland and the only grasslands that remain are along roadside ditches.

The principal drawback to recovery efforts for the Loggerhead Shrike is that the cause or causes of population declines are unknown. Nesting success and productivity seem adequate. Post-fledging losses may be considerable, but are nearly impossible to assess (radio-telemetry studies are needed). Habitat loss is believed to be one of the main factors that has limited populations of the Loggerhead Shrike. Increased losses to pesticides and automobile collisions have also been blamed. The latter may be more significant than we give it credit for since the numbers of roads on the nesting, migration, and wintering areas have increased substantially and at the same time more shrikes are hunting along roads due to a decline in alternate grassland habitats.

Habitat loss comes in a variety of forms, including: 1) cultivation of grasslands; 2) removal of shelterbelts, hedges, and isolated trees and shrubs; 3) shrub and tree invasion of grassland sites; and 4) loss of nesting and wintering territories to urbanization and industry. Nevertheless, in many parts of its nesting range, suitable habitat remains unoccupied. Many have postulated that habitat on the winter range may be limiting and that prairie populations could be facing serious competition for remaining habitat with local resident populations. Undoubtedly, habitat losses have and are still occurring on the winter range. However, my impressions from having spent three weeks last spring examining shrike habitat use in Texas and Louisiana is that here too there is plenty of available habitat that is unused or underutilized.

The most recent draft of the national recovery plan for Loggerhead Shrikes (Telfer 1990) calls for establishment of stable or increasing breeding populations of over 1000 adults in each of Alberta, Saskatchewan, and Manitoba, and a stable population of the eastern subspecies of over 1000 birds in Ontario and Québec combined. This will require action in three fronts: 1) background studies and research; 2) management actions; and 3) socio-political actions.

Background studies and research are required in order to understand why populations are declining; until this is known, recovery measures will remain tentative. These would include: 1) monitoring status and distribution (to document population changes and response to management initiatives); 2) assessing population dynamics (productivity, recruitment, mortality and survival rates, etc.); 3) delineating the winter range (currently, there are only five recoveries of prairie Canadian shrikes on winter range); 4) qualitative descriptions of habitat (does suitable but unoccupied habitat suggest a lack of shrikes to fill available habitat or our inability to assess habitat needs?); and 5) quantitative assessments of breeding and wintering habitat. The status and distribution of Loggerhead Shrikes has been monitored in southwestern Manitoba since 1987. Normally, about 250 pairs are found each year, a total that has remained constant despite ever-increasing survey time and effort, and better knowledge on where and how to find them. In the northern half of the intensive study area, populations have declined by at least 38% since 1989. Shrike survey routes set up in southwestern Manitoba during 1987 and 1989 will be resurveyed as part of a prairie-wide effort to reassess the species' status in 1992. Additional surveys are also planned to assess the status of the endangered subspecies in southeastern Manitoba.

Since 1987, nearly 600 shrike nests have been monitored and over 2000 young and adult shrikes have been banded. Our understanding of population dynamics and limiting factors in Manitoba have increased immensely, but the real benefits of this long-term study are just emerging. In 1991, for instance, 4% of nesting adults in southwestern Manitoba were previously banded. While this may not sound like a high percentage of returns, it is far higher than those recorded in other prairie study sites, and we expect these percentages and our knowledge on management concerns to increase substantially in coming years. These results have generated interest in other circles; University of Manitoba students who assisted in the Grasslands Birds Study in 1991 will be initiating studies on Loggerhead Shrikes and Baird's Sparrows (*Ammodramus bairdii*) during 1992. Local conservation organizations from Pierson and Reston have expressed an interest in our research and have applied for Endangered Species Lotteries funding to assist in management initiatives for Loggerhead Shrikes and Burrowing Owls.

Management actions proposed in the draft Loggerhead Shrike Recovery Plan, include: 1) protection of key nesting habitats (might even include protection of known nesting areas in some areas since certain nest sites are used on an annual basis); 2) creation of nesting areas (including shelterbelt establishment, or planting trees and shrubs in large expanses of open grassland); and 3) development of contingency plans should shrikes continue to decline (including exploring captive-breeding and reintroduction).

Socio-political actions outlined in the recovery plan include: 1) working to increase support for shrike conservation among nongovernment organizations and government agencies in Canada, United States, and Mexico; and 2) developing public support and awareness.

Public support and awareness for threatened and endangered grassland birds in Manitoba has been enhanced by: 1) public presentations to naturalists, school groups, and other interested organizations; 2) displays and exhibits at National Wildlife Week, the Brandon Winter Fair, etc.; 3) newspaper articles, radio, and television reports; 4) tours of the study area (through Operation Lifeline, and to local interest groups); 5) preparation and distribution of brochures (a prairie-wide brochure is nearing completion for the Ferruginous Hawk and one is planned for the Loggerhead Shrike); 6) involving local enthusiasts and conservation organizations in day-to-day activities and management initiatives; and 7) our continued presence in the southwest (including regular contact with landowners where these species occur).

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PEREGRINE FALCON RECOVERY PROJECT: MANITOBA PERSPECTIVE

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INTRODUCTION

Once plentiful and nesting across Canada, the *anatum* subspecies of the Peregrine Falcon (*Falco peregrinus*) was nearly extinct by the 1960s. In 1970, a joint Canadian-American study predicted that the subspecies would disappear from North America by the end of the decade (Cade and Fyfe 1970). The decline was related to lowered reproductive success due to chemical pesticides, especially DDT (Erickson et al. 1988). International concern over the decline of the subspecies led to the development of a Canadian recovery effort.

Between 1976 and 1987, 563 young peregrines have been raised at the Canadian Wildlife Service (CWS) breeding facility at Wainwright, Alberta, and released across Canada in an attempt to enhance recovery of the species (Holroyd and Banasch 1990). Eighty percent of the fledglings have survived to independence three weeks after the release and their survival is only a start (Davies 1987). The ultimate goal for the prairie provinces, as described in the National Recovery Plan, is to establish a total of 10 territorial pairs within this area by 1992.

Historically, the Peregrine Falcon's occurrence in Manitoba was regarded as a regular migrant and a rare breeder. Manitoba's recovery program began in 1981 with the first release of captive-bred falcons in Winnipeg. In 1990 and 1991, the Manitoba Peregrine Falcon Recovery Project expanded outside Winnipeg to include Brandon, Portage la Prairie, and Gimli. From 1981 to 1991, the Endangered Species and Nongame Section of the Wildlife Branch, Manitoba Department of Natural Resources (DNR), supervised the release of Peregrine Falcons in Manitoba. This report discusses the recovery efforts in Manitoba up to December 1991.

RELEASES

During the last 10 years, 79 Peregrine Falcons have been released in Manitoba (Table 1), the majority

Table 1. Summary of Peregrine Falcons in Manitoba 1981 to 1991.

Total number of birds (hacked and wild)	92[a]
Total number birds hacked	79
Largest hack in a single year (1991)	30
Sex ratio of young birds	42M, 45F
Returned and identified in Manitoba > 1 year after release	4M
Originating outside of Manitoba	1M, 4F
Identified outside Manitoba (Edmonton, Regina, Vera Cruz, and Fargo)	4
Killed (accidents)	15
Injured (2 died, 2 euthanized)	5
Unreleasable; education birds (Quebec, British Columbia, and Manitoba)	4
Number shot	3
Killed by predator (suspected)	1
Rehabilitated and released	0
Unknown (up to 1990)	37

[a] Total does not include migrants, or unidentified banded peregrines.

(about 80%) originating from the CWS peregrine breeding facility at Wainwright, Alberta. Some peregrines came from the Saskatchewan Cooperative Falcon Project, University of Saskatchewan, Saskatoon (15%), and the Raptor Research Centre, McGill University, Quebec (5%).

Between three and eight (average four) Peregrine Falcons were released each year (over the entire 10 year period) from residential and urban buildings in Winnipeg including Fort Osborne Barracks, Mary Speechly Hall (University of Manitoba), Confederation Building, Grain Exchange Building, United Grain Grower's Building, and 200 Tuxedo. Brandon became involved with the peregrine release project in 1990, releasing birds from the roof of the McKenzie Seeds building during the next two years. In 1991, Portage la Prairie and Gimli became involved, releasing peregrines from the roof of Regency House and an old three-story school house respectively. The largest release (30) occurred in 1991 when Winnipeg released six and fostered two, Brandon 12, Portage la Prairie six, and Gimli four birds.

From 1983 on, from one to four peregrines were observed in Winnipeg during the breeding season, although no nesting took place. To encourage nesting, several nest-boxes were placed on downtown rooftops —two on the Delta Winnipeg Hotel, one on the Royal Bank Building, and one on a condominium at 200 Tuxedo. Additional nest-boxes were constructed on the roofs of three apartment blocks, one at the University of Manitoba, and two more at Stony Mountain Penitentiary. Although peregrines from the 1990 release were not observed in Brandon, nest-boxes were installed in 1991 on several buildings.

Mortality encountered during the program included accidents and shootings. Over the course of 10 years, 15 peregrines are known to have been killed accidentally, the majority were young of the year which were relatively inexperienced fliers. Three birds were shot. The whereabouts of at least 37 birds are unknown: some birds may have survived to reproduce.

NESTING

In 1988, a pair of peregrines (5P9, male released in Winnipeg, and P27, female from Minneapolis, Minnesota) were observed in downtown Winnipeg during the summer and fall. In 1989, these birds returned to downtown Winnipeg, and for the next two years, they nested and raised eight chicks on the Delta Winnipeg Hotel (Table 2).

Behaviours associated with courtship such as cooperative hunting and feeding of the female by the male were observed each spring from 1989 to 1991. During early courtship, copulation was also observed frequently. Nest scrapes were observed in the east and west nest-boxes and on a natural ledge on the northeast corner of the Delta Winnipeg Hotel, and early in the pre-nesting season, the female would frequent all three locations.

Table 2. Summary of nesting on Delta Winnipeg Hotel, 1989 to 1991.

	1989	1990	1991
First sighting of pair	Mar. 31	Mar. 28	Apr. 3
Number of eggs laid	4	3	4
Nesting location[a]	W NB	E ledge	W NB
Est. date of last egg laid	May 11	May 4	May 4
Est. date hatch	June 9-11	June 1-4	June 1-3
Number chicks hatched	4	2	2
Sex	4M	1M, 1F	2F
Banding date	June 27	June 29	July 4
Date first flight	July 14	July 13	July 13
Age at first flight (days)	34-36	40-43	40-42
# survived until departure	3	2	2

[a] W = West, E = East, NB = Nest-box

A video camera provided by Advance Electronics was placed on or near the nest ledge each year to allow for a picture of the nest-box interior and one-half the nest ledge. A video monitor was placed in the Delta Winnipeg Hotel lobby for viewing the growth and behaviour of the falcons and a video cassette recorder was used to record activities. The general public was encouraged, through radio, newspaper, and television press releases to view the falcons in the nest-box via the television monitor and to view a DNR display on peregrines. Volunteers and staff were stationed in the hotel lobby to answer questions and solicit donations for the Peregrine Falcon Recovery Project. These peregrines and their offspring were commonly observed to roost, perch, hunt, and feed on or near the following buildings: Delta Winnipeg Hotel, First City Trust, Royal Bank, J.R. Richardson Building, Trizec, Newport Centre and Toronto Dominion Centre among others.

In 1989 and 1991, four eggs were laid in the west nest-box. In 1990, three eggs were laid on the triangular ledge overlooking Portage Avenue and Smith Street (Table 2). During late April, both the female and male shared incubation responsibilities.

The nestling period averaged approximately 40 days. Initially, the male provided most of the food, but during the later part of the nestling period, the female also hunted. In 1989, the female was observed chasing the male and calling on many occasions. These behavioral observations suggested that this inexperienced male was not bringing enough food, and supplemental feeding of two or three quail (*Coturnix coturnix*) per day was initiated for one month.

Young falcons were capable of walking along the ledge within two weeks of hatching. After six weeks, the young falcons fledged. During the early flight period, some problems occurred. In August 1989, the desiccated carcass of one young peregrine was found inside a compartment opening into the base of the Eaton's powerhouse chimney. In 1990, one chick was found on the street. It was brought to the Assiniboine Park Zoo Hospital for treatment, then returned to the Delta Winnipeg Hotel. Ten days later the same chick had to be retrieved again from the street.

Fledglings usually stayed until late September-early October while the adults were present into November. Peregrines have been observed into December and during the last two years, a peregrine (V52, female from Cedar Rapids, Iowa) has spent the entire winter in the downtown area.

In 1990, an aerial survey over a 3,438 km route was conducted over the northern third of Manitoba for other nesting peregrines. Although no peregrines were observed, 33 potential nesting cliffs were recorded (Duncan 1990).

STUDY OF FOOD HABITS

From 1989 to 1991, food habits were determined from prey remains retrieved approximately every 10 days from rooftops and street level around the Delta Winnipeg Hotel from early May to early October. The rooftops of Eaton's Place, Eaton's, Delta Winnipeg Hotel, Newport Centre, Canada Post Office, and First City buildings were checked on a regular basis for feathers and carcasses for identification. Prey species killed by the adults during observations were also identified.

In 1991, a study was initiated to determine the abundance and availability of prey and non-prey species. Bird surveys were conducted in a method similar to the variable circular-plot technique (Reynolds et al. 1980) and the strip transect method (Emlen 1971). A total of 18 point counts and three line transects were established at 10 locations within and near Winnipeg. Four to 18 counts were conducted between May 8 and September 21, 1991 at each location. Data there were collected and included time, weather, species, sex, number, estimated distance from observer, and habitat type. Census plots were surveyed in the early morning hours between sunrise and up to two hours after sunrise. Plots were established in representative samples of several different urban habitats including riverine, downtown, suburban, industrial, forest, grassland, park, and marsh. Eight different observers collected the data from different locations through the year.

From 1989 to 1991, 356 individuals of 68 species and two individuals of two mammalian species were identified from prey remains collected primarily in downtown Winnipeg. Ninety-six percent of the remains (341) were identified to species and 4% were identified to family.

The prey species most frequently taken by Peregrine Falcons between 1989 and 1991 were Rock Dove (*Columba livia*) (22.6%), Sora (*Porzana carolina*) (12.6%), Northern Flicker (*Colaptes auratus*) (11.1%), Black-billed Cuckoo (*Coccyzus erythropthalmus*)

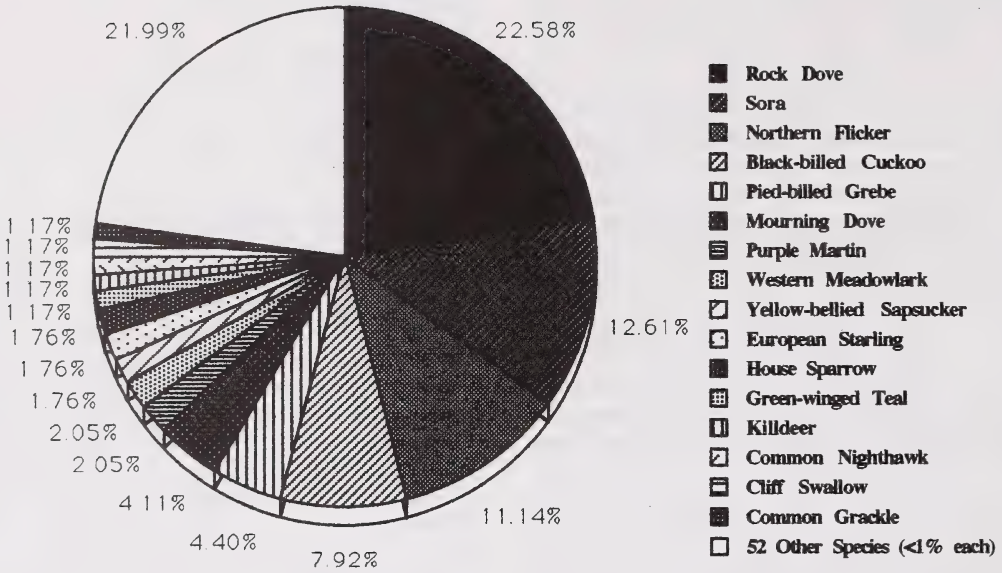

Figure 1. Percent frequency of prey used for species that composed 1% of the diet of Peregrine Falcons in Winnipeg, 1989 to 1991.

(7.9%), Pied-billed Grebe (*Podilymbus podiceps*) (4.4%), and Mourning Dove (*Zenaida macroura*) (4.1%). Of the prey identified in the diet of Peregrine Falcons in Winnipeg, the top six of 68 species accounted for 62.7% of the peregrines' diet. Rock Dove and Sora remained proportionally larger in the diet throughout each of the three sample years than all other species. Sixteen species composed 1% of the diet of Peregrine Falcons, and 52 other species represented 1% of the prey remains, which accounted for 22% of the total diet (Figure 1).

In 1991, 108 species were identified and 9457 sightings were made during bird surveys within and surrounding Winnipeg (including Oak Hammock Marsh, approximately 10 km north of Winnipeg). Eight species composed 53% of available birds. Rock Dove was the most abundant bird recorded (23.4%), followed by Franklin's Gull (*Larus pipixcan*) (16.4%), Ring-billed Gull (*L. delawarensis*) (7.8%), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) (5.8%), Mallard (*Anas platyrhynchos*) (5.1%), Red-winged Blackbird (*Agelaius phoeniceus*) (3.9%), House Sparrow (*Passer domesticus*) (3.4%), and Snow Goose (*Chen caerulescens*) (3.2%).

The average number of birds observed over the season in different habitat types was highest in the industrial areas and marshes (Figure 2). Although the variety of species observed was relatively high in the marsh (12 species), it was considerably lower (three species) in the industrial areas (Figure 3). The number of species was highest in rural parks (17 species) and creeks (14 species).

Sixteen of 39 species preyed upon by Peregrine Falcons including Sora, Northern Flicker, Black-billed Cuckoo, and Pied-billed Grebe were taken more frequently than they occurred within the city of Winnipeg. Five additional species were taken in proportions approximately equal to their availability: Rock Dove, American Woodcock (*Scolopax minor*), Common Snipe (*Gallinago gallinago*), and Western Kingbird (*Tyrannus verticalis*); and 18 species were taken in proportions less than their relative abundance: Franklin's Gull, Red-winged Blackbird, House Sparrow, and Mallard. Some of those species taken in proportions less than their availability were not detected in prey remains (unpublished data).

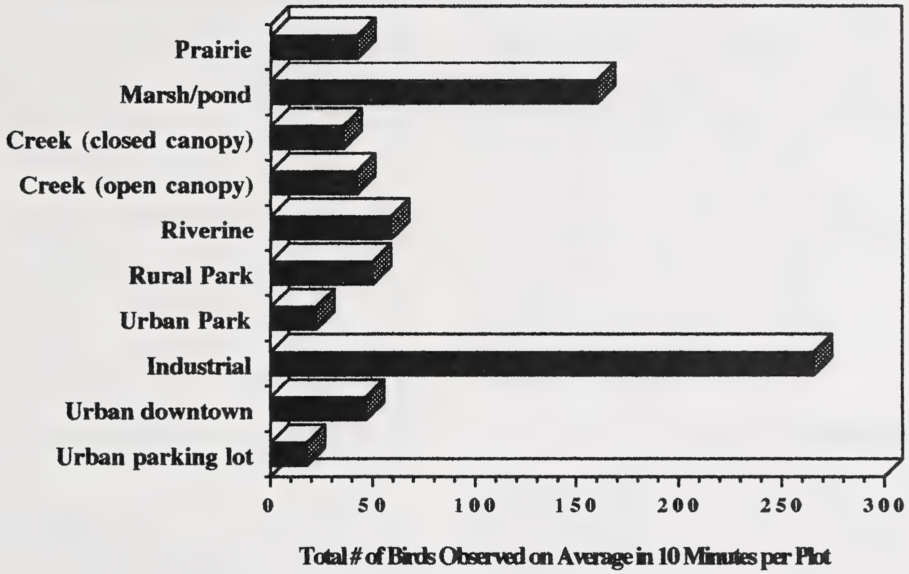

Figure 2. Average total number of birds observed per habitat type within or near Winnipeg, spring-fall 1991.

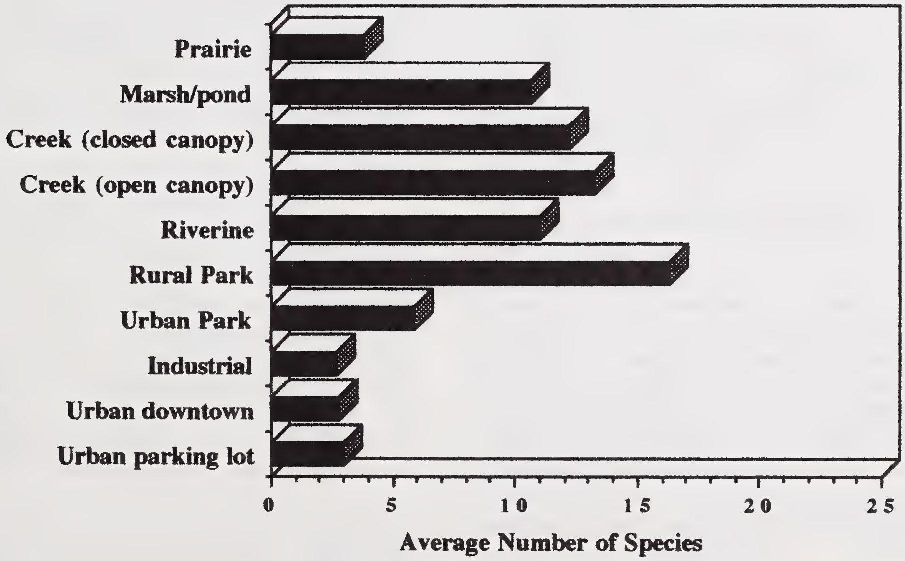

Figure 3. Average number of bird species per habitat type within or near Winnipeg, spring-fall 1991.

Table 3. Summary of pesticide analysis on unhatched egg retrieved from the Delta Winnipeg Hotel, 1991.

Pesticide	Delta Winnipeg Sample ppm (wet weight)	Alberta Average 1991	Canadian Average [1980-1987 (*anatum*)]
HCB	-	0.11	0.279
PCB	2.37	2.98	3.97
Heptachlor Epoxide	0.20	0.38	0.236
Dieldrin	0.04	0.14	0.287
DDT	-	2.84	9.23
DDE	3.62	5.94	9.13

PESTICIDES

In 1990, two of three eggs hatched and in 1991, only two of four eggs hatched from the peregrines nesting on the Delta Winnipeg Hotel. One unhatched egg retrieved in 1991 was sent to the Status and Surveys Section of the Fish and Wildlife Division, Edmonton for analysis (Table 3). It was determined that embryo failure resulted halfway through the incubation and development period. Thin crack-lines encompassed the entire surface of the egg.

The level of DDE found in the Manitoba egg sample appears to be fairly low as critical levels which cause thinning of the eggshell and subsequent failure are around 15-20 ppm DDE (Peakall et al. 1975). Embryo failure resulting halfway through the incubation and development period, and the presence of thin crack-lines which encompassed the surface of the egg, may have been caused by excessively rough handling of the egg by the peregrines.

On September 9, 1991, P27—the resident female which nested on the Delta Winnipeg Hotel during the last three years—was found at the corner of Bishop Grandin and Waverly, Winnipeg, where she had fallen after a collision, presumably with a hydro wire. Both legs were paralysed. She was rushed to the Provincial Vet lab, then to the Assiniboine Park Zoo Hospital for treatment. Unfortunately, she lived only a couple of days.

One set of tissue samples from this bird was sent for analysis. The remarkably high DDE level in her fat content called for a second set to be analyzed for verification. Additional brain, fat, and breast muscle samples from the Delta female, and comparable samples from a young peregrine found dead in Portage la Prairie, were also sent as a control sample (Table 4).

Table 4. Organochlorine residues in the tissues of an adult and a hatch-year female Peregrine Falcon which died in Manitoba, 1991.

	Organochlorides (ppm wet weight)				
Tissue Sample	HCB	beta BHC	H.E.	PCB	DDE
Adult Female (P27)					
Fat (Sample 1)	.001	.320	3.73	20.7	196.5
Fat (Sample 2)	-	.422	6.38	39.4	125.0
Brain (Sample 1)	.005	.007	.088	0.73	3.460
Brain (Sample 2)	-	-	.344	-	12.85
Muscle	-	.024	.772	3.14	74.50
Hatch-year Female (GY)					
Fat (Sample 1)	.100	-	.017	-	.046
Fat (Sample 2)	-	-	.049	-	.097
Brain	-	-	-	-	.027
Muscle	-	-	-	-	.010
Liver	-	-	0.12	-	.010

There were no significant findings for the final diagnosis of P27. The necropsy did not show any abnormal conditions, and her weight (950 g) was not any lower on average (899 ± 75 g) than other *anatum* adult female peregrines (Court et al. 1988). As expected, body fat reserves were considerably lower than the hatch-year female's fat reserves.

Results showed that DDE in the fat averaged 160.7 ppm, and the brain tissue averaged 8.15 ppm wet weight for the Delta female. The highest DDE level of 12.85 ppm found in the brain stem of this female was approximately the same as the highest average brain tissue level found in Canadian raptors during 1967 to 1985 (Noble and Elliot 1990). The DDE in muscle tissue was also high (74.5 ppm) as compared with an adult male peregrine (47.1 ppm) found dead in the NWT (Court et al. 1990).

DISCUSSION

The initial success of the program was realized in 1983 when peregrines began returning to their place of origin. One to four Peregrine Falcons were observed in Winnipeg each year during the breeding season. Other Peregrine Falcons originating from the United States were also attracted to Winnipeg. Although peregrines from the 1990 release were not observed in Brandon, nest-boxes were installed in 1991 on several buildings in preparation for their arrival and to encourage nesting. The mass hack of 30 Peregrine Falcons in 1991 from four urban centres holds much promise for a number of these birds to return to Manitoba in spring, 1992.

In 1989, another milestone in the program was reached when a pair of Peregrine Falcons nested on the Delta Winnipeg Hotel. Over the next three years they successfully raised eight young, and seven of these birds survived until their departure. In 1990 and 1991, one offspring male (born in 1989) from the Delta pair returned to Winnipeg. He paired with two different females at the University of Manitoba during these years but they failed to produce a clutch. Age and inexperience were likely the reasons why they did not produce young. There is a good chance, however, that if these birds return in 1992, they will reproduce.

A successful aspect of the peregrine release program in Manitoba was the favourable media attention and the opportunity for public education to the plight of an endangered species. Each year, between 30 and 60 news articles were released via newspaper, television, and radio. Shopping mall displays during Wildlife Week, the display and television monitor at the Delta Winnipeg Hotel, public interpretation at shopping malls, interpretation while viewing peregrines from parking lots and parks surrounding hack sites, and university lectures all provided unique opportunities for education.

Mortality encountered during the program included accidents and shootings. Over the course of 10 years, 15 peregrines were killed accidentally; the majority were young of the year and relatively inexperienced fliers. Three birds were shot. The whereabouts of at least 37 birds are unknown; some of these birds may have survived to reproduce.

Some concern was expressed by the public over the potential over-exploitation of local songbirds such as robins and warblers by Peregrine Falcons. The prey preference study conducted from 1989 to 1991 suggests that a wide range of species are used by Peregrine Falcons in Winnipeg, but only a few species account for a majority of the diet. The main prey species, Rock Dove, appears to be selected on the basis of frequency. Sora, Northern Flicker, and Black-billed Cuckoo are relatively uncommon in Winnipeg as shown by the prey availability study, but they are selected for prey during the early to mid-season, suggesting that there is a local irruption of these two species, or there is some energetic benefit to peregrines when they hunt these birds. Rock Dove, Sora, Northern Flicker, Black-billed Cuckoo, and Pied-billed Grebe constituted a relatively large portion of the diet (60%) and should be considered important prey. Local songbirds were hunted by peregrines, but a very low percentage of these individuals was present in the diet.

Prey that fly through open areas in Winnipeg over parking lots, buildings, industrial areas, or above the parkland canopy may be more susceptible to predation by peregrines. Prey behaviour may provide additional opportunities for capture by peregrines, or they may concentrate on prey with obvious flash patterns in the feathers (e.g., Northern Flickers' bright yellow undertail coverts and primaries). Hunter et al. (1988) suggest that selection of particular prey species likely was influenced by a combination of factors in their study area including prey habitat, susceptibility, abundance, behaviour, physical characteristics, and predator characteristics such as hunting ability.

High levels of organochlorines, especially DDE levels in the Delta female, raised the possibility of indirect mortality through poisoning. If P27 was stressed and she had low fat reserves, there is a possibility that the organochlorines in her system contributed to her accidental death. Peakall et al. (1990) suggest that the best estimate of critical levels of DDE in the brain which directly causes mortality are above 200 mg/kg, but there are no studies available which suggest how and to what degree organochlorine levels can affect flight performance. Court et al. (1990) stated that organochlorines such as Dieldrin, DDE, Heptachlor Epoxide, and PCBs have been implicated as the cause of death in a number of raptor species. They proposed that birds retain these lipid-soluble compounds in body reserves and are subsequently poisoned when reserves are suddenly utilized in times of stress, specifically during breeding, the moult, or migration. Adult females have shown evidence of stress during the breeding season and show a considerable drop in body weight between arrival and the nestling-rearing stage, up to a 20% reduction in some cases. Birds leaving the breeding grounds carrying the highest levels of organochlorines might be the least likely to survive the wintering season (Court et al. 1990).

The hatch-year peregrine hacked in Portage la Prairie did not show significant levels of organochlorines as expected. The levels obtained in this young bird, however, demonstrate that they retain some residues originally present in the egg yolk (Court et al. 1990). Organochlorines could also have been picked up from either the quail it was fed, or if it managed to kill and eat some prey during the 15 days it was flying after release from the hack-box.

ACKNOWLEDGMENTS

We would like to thank the following organizations and people for their contributions in the development and support of the Manitoba Peregrine Falcon Recovery Program: Members and volunteers of the Manitoba DNR who supervised the program, committed themselves to public education and fund-raising, and those people too numerous to mention, who built and placed hack-boxes, nest-boxes, conducted surveys, and rescued peregrines over the course of ten years. Special thanks to Robert W. Nero for his relentless dedication and perseverance to Manitoba's peregrine recovery effort. We would also like to thank the following organizations: The Peregrine Falcon Recovery Project Manitoba, CWS, the Zoological Society of Manitoba, Manitoba Wildlife Rehabilitation Organization, Assiniboine Park Zoo, the Delta Winnipeg Hotel, the United Grain Growers, McKenzie Seeds, Eaton's, Advance Electronics, SWAT Exterminators, Manitoba Lotteries Foundation, Winnipeg Real Estate News, Gimli Environmental Council, Portage Natural History Society, Sunridge Management, University of Manitoba, and the Alberta Fish and Wildlife Division.

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ORGANOCHLORINE CONTAMINANTS IN MIGRANT AND RESIDENT PREY OF PEREGRINE FALCONS IN PANAMA, VENEZUELA, AND MEXICO

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ABSTRACT

During 1984 to 1989, we collected Peregrine Falcon (*Falco peregrinus*) prey species, in the fall and the following spring, in Panama, Venezuela, and Mexico to determine the levels of organochlorine contamination. The mean DDE levels, by country, for all samples ranged from 0.28 to 0.68 ppm; for spring samples the DDE levels ranged from 0.02 to 1.12 ppm. The spring migrants collected in Mexico exceeded 1.00 ppm DDE, the more conservative DDE level considered sufficient in prey to effect decreased productivity in peregrines. Some species collected in the fall arrived with more than 1.00 ppm DDE in their tissues. Detected DDT levels were also low, indicating the presence of an alternate source for the higher DDE levels, possibly in North America (Banasch et al., in press).

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FOOD HABITS OF NESTING PRAIRIE FALCONS IN SOUTHERN ALBERTA, CANADA

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SUMMARY

Diet and feeding behaviour of eight pairs of nesting Prairie Falcons (*Falco mexicanus*) in southern Alberta were examined in 1989 and 1990. Prey were identified by direct observation of prey delivered to the nest site, and by examination of prey remains from perch sites and pellets. Comparison of species composition derived using the two techniques demonstrated that collections of pellet and prey remains misrepresented the percent frequency and percent biomass of Richardson's Ground Squirrel (*Spermophilus richardsonii*) and birds in the diet. Using direct observation we determined that Richardson's Ground Squirrels accounted for 68% of all delivered prey items (n = 250 items). Analysis of prey remains and pellets was used to identify the species of birds and small mammals in the diet. Birds, primarily Western Meadowlark (*Sturnella neglecta*), European Starling (*Sturnus vulgaris*), and Horned Lark (*Eremophila alpestris*), comprised 27% of the diet. The remaining 5% of the diet consisted of small mammals. Male falcons delivered 71%, 71%, and 57% of prey during incubation, nestling, and fledgling stages, respectively. Primary prey of male falcons switched from Richardson's Ground Squirrels to birds in June. This change corresponded in time with the doubling of prey delivery rates of female falcons. Female falcons delivered primarily ground squirrels throughout the nesting cycle. A conservation implication of this data is that Richardson's Ground Squirrels and their habitat must be maintained if Prairie Falcons are to continue breeding in southern Alberta.

WHOOPING CRANE CONSERVATION

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INTRODUCTION

After listening to various presentations in this workshop and in the two previous workshops it appeared evident to me that no single individual or institution can prevent species from becoming endangered. It has taken and will take a cooperative role by many participants. Nowhere is there a better example of cooperation in wildlife management than in the story of the Whooping Crane (*Grus americana*). The Whooping Crane is known as the symbol of efforts to preserve rare and endangered species in North America (United States Fish and Wildlife Service [USFWS] 1986, Cooch et al. 1988).

In Canada the Whooping Crane program has benefitted from the cooperation of organizations such as the Canadian Wildlife Service, the Saskatchewan Museum of Natural History, the Canadian Parks Service, the Governments of Manitoba, Alberta, and, in particular, Saskatchewan, the Whooping Crane Conservation Association, the Saskatchewan Natural History Society, and the Saskatchewan Wildlife Federation. In the United States there are an equivalent number of organizations, all with the same common goal "To prevent the extinction of the Whooping Crane and other endangered species."

POPULATION AND RANGE

The Whooping Crane was never a very numerous species, the best estimate of the population is about 1350 individuals around 1865 (Allen 1952). At that time, Whooping Cranes occupied their primary breeding range which extended from central Illinois to the northwest through Iowa, Minnesota, North Dakota, Manitoba, Saskatchewan, and into Alberta. The Great Plains of Canada and the United States still contained an abundance of lakes, marshes, and other wetlands where Whooping Cranes could safely nest and feed. During the late 1800s and early 1900s the Whooping Crane breeding area underwent a drastic change. Settlement of the prairies began and prairie wetlands and uplands were converted to agricultural lands. During this settlement period, Whooping Cranes, besides losing the major portion of their breeding habitat, were hunted for food and feathers. Museums and collectors were also after specimens and eggs. In Manitoba all known nests between 1871 and 1906 had their eggs taken by collectors. The last nesting record for the United States came from Iowa in 1894. Manitoba's last known nesting was in 1906, followed by Alberta in 1914 and the last nest in the prairies of southern Canada occurred in Saskatchewan in 1922 or perhaps as late as 1927 (Allen 1952, Johns, in press). As a result the migratory population plummeted to a low of only 16 birds by 1941 (Allen 1952). A small nonmigratory population persisted in Louisiana until 1948 when it finally died out.

Today, the Whooping Crane population numbers around 212 birds. One hundred and forty-four birds are in the wild and another 68 birds are in captive breeding facilities. The current breeding range consists of a few small areas within Wood Buffalo National Park (WBNP) (Kuyt and Goossen 1987).

The historical wintering areas of Whooping Cranes were the coasts of western Louisiana and Texas, and the high plateaus of central Mexico (Allen 1952). Today, Whooping Cranes winter on the Texas coast, on and near the Aransas National Wildlife Refuge (ANWR) and an experimental population winters in central New Mexico.

The migration corridor of the Aransas/Wood Buffalo population of Whooping Cranes extends north from the ANWR through the states of Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota, and into southeastern Saskatchewan. From here the birds cross the province in a diagonal towards the northwest, across northeastern Alberta and into WBNP (Kuyt 1992).

LIFE CYCLE

Whooping Cranes begin the year on their wintering grounds, feeding on the rich invertebrate life in the coastal marshes of southern Texas. The birds are in small groups, each defending a small winter territory from intruders. Groups consist of single birds, pairs, family groups (usually 2 adults and 1 young), and larger non-breeder groups.

During early April, these small winter flocks begin the northward migration either alone or in combination with other winter groups. The cranes begin arriving in northern WBNP 19 to 28 days after leaving Texas (Kuyt 1982). Shortly after their arrival, the breeding birds begin nest construction.

Nests are generally constructed of bulrush (*Scirpus* sp.), sedge (*Carex* sp.), or Common Cattail (*Typha latifolia*), in about 25 cm of water. Usually two eggs are laid (92% of the time), sometimes only one egg (7%), and rarely 3 (1%) (Cooch et al. 1988). Incubation takes 29-30 days (Kuyt 1982). After hatching, young Whooping Cranes feed in the shallow marshes (invertebrates and small vertebrates) and also in uplands (berries) with their parents for the remainder of the summer.

Usually after the middle of September, Whooping Cranes begin their southward migration. The autumn migration is the reverse of that of the spring, with the exception that the cranes may spend several days or weeks in the south-central portion of Saskatchewan feeding on waste grain before continuing with migration to Texas.

MANAGEMENT

Protection Of Whooping Cranes

Whooping Cranes have been protected in North America since the signing of the Migratory Birds Treaty with the United States in 1916. Their breeding area has been protected as a national park since 1922, and the wintering grounds have been protected as a national wildlife refuge since 1937. The Canada Wildlife Act of 1974 provides additional authority to undertake work on any endangered wildlife in Canada.

A memorandum of understanding exists between Canada and the United States to share equally in the decision making concerning the direction that the cooperative Whooping Crane program should take. A Canadian Whooping Crane Recovery Plan (Cooch et al. 1988) has been in effect since 1987. Its purpose is to provide guidelines to direct the recovery of the species to the point that it can be downlisted to threatened from its current endangered status.

Management On The Wintering Area

During the winter, censuses are conducted on a weekly basis, by the USFWS, to determine and document: the current winter population; movements of colour banded individuals; new pair formations; and any mortality that may occur. Upland foraging habitat is being managed by periodic burning to control shrubby growth and to stimulate the production of acorns, which are a favourite upland food of the wintering cranes. There have been attempts to prevent destruction by erosion of the cranes aquatic foraging habitat, by sandbagging portions of the Gulf Intra Coastal Waterway (T. Stehn, pers. comm.). During 1991 an attempt was made to create new marsh habitat, to offset losses that occur due to erosion, along the waterway.

Management On The Breeding Grounds

During the breeding season surveys are carried out to locate Whooping Cranes and to identify breeding pairs and their egg laying dates for later manipulation and removal of eggs. Late in the incubation period eggs are tested for viability. Each pair checked is left with at least one viable egg in its nest. Nonviable and surplus viable eggs are removed from nests. The surplus eggs have been placed into captive rearing facilities at the Patuxent Wildlife Research Center (PWRC) in Maryland and the International Crane Foundation (ICF) in Wisconsin, or into Sandhill Crane (*Grus canadensis*) nests in Idaho.

During the summers of 1977 through 1988 young Whooping Cranes were colour banded to provide information on location and movements of marked birds, age of sexual maturity, fidelity of birds to their mate and territory, reproductive capacity, identification of important migration habitat, and longevity of the Whooping Crane (Kuyt 1979).

Efforts To Increase The Population

Several approaches have been employed to increase the Whooping Crane population. Whooping Cranes lay two eggs, generally only one young will survive to fledging. Beginning in 1967, surplus eggs were removed and placed into captive breeding facilities. To date there are 68 birds in captive breeding facilities. There are 38 birds at the PWRC, another 28 birds at the ICF, and two birds at the San Antonio Zoo in Texas. There may be another captive breeding flock established, in the near future, at the Devonian Conservation Research Centre in Alberta, a branch of the Calgary Zoo. The purpose of the captive breeding facilities is to provide offspring that could be released into the wild to create additional discrete populations. To date only one or two birds have been released (Grays Lake, Idaho) and none survived.

Between 1975 and 1987 the majority of the eggs removed from WBNP were transferred to Grays Lake National Wildlife Refuge in Idaho, in an attempt to establish another wild population. Here the eggs were placed into nests of greater Sandhill Cranes after the removal of the Sandhill Crane egg. The Sandhill Cranes raised these foster young as if they were their own. This population peaked at 33 birds in 1984. However, years of successive drought leading to poor production of foster young, abnormally high mortality and no pair formation or breeding attempts by the Whooping Cranes has reduced the population to 12 birds (R. Drewien, pers. comm.). A recent study of the vocalization patterns of these foster reared Whooping Cranes has been completed, indicating that vocalizations are learned from other cranes (Carlson, in press). This indicates a degree of imprinting that may have severe consequences in any release of captive reared birds or further attempted foster rearing of Whooping Cranes, especially if they cannot communicate adequately with each other or with wild Whooping Cranes that they may encounter.

Between 1975 and 1991 eggs in WBNP, have been tested for viability, this testing and the transfer of viable eggs into nests with nonviable eggs has resulted in an increase of 16-20% in hatching success of this population (E. Kuyt, pers. comm.).

Between 1977 and 1980 a study of Sandhill Cranes was carried out in the Interlake area of Manitoba (Melvin et al. 1990). The purpose was to find a suitable population of Sandhill Cranes that could be used for another fostering experiment. The Interlake Sandhill Cranes wintered near the existing Whooping Crane flock and with the failure of the Whooping Cranes to breed in Idaho, any attempts to put Whooping Cranes in Manitoba through foster rearing has been put on hold.

The Future

There is an ongoing study in Michigan looking at integrating captive reared juvenile Sandhill Cranes into flocks of wild Sandhill Cranes (Urbanek and Bookhout, in press). This study was to begin testing the integration of the Red-crowned Crane (*Grus japonensis*), another white crane, in with flocks of Sandhill Cranes, until health problems with the red-crowns forced a halt to the study. If this technique were to prove successful, it may become another method of establishing a migratory flock of Whooping Cranes.

A study on the feasibility of establishing a nonmigratory flock in Florida has been completed. A test release of a few Whooping Cranes was to be attempted during the winter of 1991/92, however, due to a lack of suitable candidate birds, this release has been postponed to at least the fall of 1992.

At present there is a study looking at the feasibility of placing Whooping Cranes into Saskatchewan if a suitable technique can be developed. If successful, this would expand the breeding range, however, it may not meet the criteria for establishing a separate breeding and wintering flock.

The current Wood Buffalo/Aransas population consists of 41 potential breeding pairs and 50 subadults. During 1991 there was a potential for 40 nests, however, due to poor habitat conditions on the breeding grounds (i.e., low water levels) there were only 33 nests. From those 33 nests only eight young survive. When habitat conditions improve, most of those pairs should nest and there could be a record number of young produced.

ACKNOWLEDGMENTS

Thanks to E. Kuyt for his comments on a draft of this report.

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AN OVERVIEW OF THE FIRST INTERNATIONAL PIPING PLOVER CENSUS

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One of the difficulties that COSEWIC (Committee on the Status of Endangered Wildlife in Canada) and the United States Fish and Wildlife Service face when evaluating species' status, is the uncertainty of total population estimates. Often, accurate population numbers are not available for candidate species and biologists can only offer best guesses or general estimates based on regional counts. Prior to the 1991 census, the question as to how many Piping Plovers (*Charadrius melodus*) remained could also only be speculatively answered using regional counts and estimates (Haig et al. 1988, Goossen 1990). In this paper, we present highlights from the results of the 1991 census (Haig and Plissner, in press) and give special attention to Piping Plovers breeding in the Canadian prairies.

In 1991, Piping Plovers were counted in one of North America's most comprehensive endangered species censuses, involving over 1000 volunteers and biologists from 10 nations (Haig and Plissner, in press). Within six months, most Piping Plovers on both wintering and breeding grounds had been censused, giving biologists the first comprehensive count of this species. The census was coordinated through the four North American Piping Plover Recovery Teams (two in Canada and two in the United States). The teams were responsible for ensuring the census was done by state, provincial, and nongovernment agencies in their respective regions.

In 1991, the North American breeding population consisted of approximately 5,480 adults. The Northern Great Plains of the United States and the Canadian prairies harboured the majority (63%) of breeding Piping Plovers. Piping Plovers in prairie Canada (Alberta, Saskatchewan, Manitoba, and northwestern Ontario) constituted 41% of the Great Plains/prairie population and 26% of the total Piping Plover population. Most Piping Plovers in prairie Canada were found in Saskatchewan. About 1,170 adults were counted there, representing about 21% of the total Piping Plover population. The previous highest count in Saskatchewan was in 1984 when 802 individuals were counted for a provincial estimate of 2000 to 2500 (Harris et al. 1985). The most populated breeding site in North America in 1991 was Lake Diefenbaker which harboured 5% of all adult Piping Plovers counted during the 1991 breeding census. Alberta had the next highest provincial count in prairie Canada with 180 adults. This count, however, is 108 adults less than were counted in 1986 (Wershler and Wallis 1987). Previous population estimates for Manitoba have ranged from about 120 adults (Haig 1987) to 200 (Koonz 1988). In 1991, however, only 80 adults were found.

All Piping Plovers in the Great Lakes area occurred in Michigan with the exception of one bird in Wisconsin. No plovers were found at Long Point on Lake Erie, where the last confirmed Canadian Great Lakes nesting was documented in 1977 (Lambert 1987). In Atlantic Canada, approximately 510 Piping Plovers were counted. New Brunswick harboured 40% of the Atlantic Canada Piping Plover population followed by Nova Scotia with 22%.

About 3,450 wintering Piping Plovers were counted on the Gulf of Mexico coast, the United States Atlantic coast, and some Caribbean Islands. Most (55%) wintering Piping Plovers were found in Texas.

The 1991 census resulted in more Piping Plovers being found on both wintering and breeding grounds than previously estimated. No doubt the major reason is the increased search effort. Additional international surveys are required to demonstrate any population trends. Concern for the species must remain as the western population may be in decline (Prindiville Gaines and Ryan 1988).

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THE BURROWING OWL RECOVERY PROGRAM

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Three years ago after the last Prairie Conservation and Endangered Species Workshop, Burrowing Owl (*Athene cunicularia*) people stayed to work on a draft recovery plan. That plan was submitted to RENEW (Recovery of Nationally Endangered Wildlife) for approval on May 22, 1990 (Haug et al. 1990).

While awaiting approval for the plan the recovery team is proceeding with its implementation. This article is a quick overview of the major recommendations of the recovery plan and of some of the projects we have underway for the Burrowing Owl.

First of all a look at the goals of the recovery plan. We have established a target of 2700 pairs of owls in Canada and individual provinces have also established targets. These targets, 100 pairs in Manitoba, 1500 pairs in Saskatchewan, 1000 pairs in Alberta, and 50 in British Columbia also show the general distribution of the Burrowing Owl at present. The vast majority of our population is in Saskatchewan and Alberta.

To meet these goals the plan identifies six major action areas. I wish to give you a review of the recovery plan by a quick look at some projects under taken in each of these six action areas.

MAINTAIN AND INCREASE POPULATIONS ON THE BREEDING GROUNDS

Public education is an important way to lower mortality from human caused activities such as shooting. Several initiatives are underway here. Alberta has published a Burrowing Owl brochure which has been distributed widely. A modified version, to cover the prairies, will be produced shortly. In British Columbia posters have helped create awareness.

Media have covered the Burrowing Owl with banding or other stories on several occasions. We also assisted John and Janet Foster to produce a film on Burrowing Owls for TV Ontario and Japanese Television. Although the film had been shown in Japan and Ontario, few people in the Burrowing Owl range have seen it yet. Wildlife is always more attractive when it's far away and exotic. Nonetheless we are optimistic it will eventually be a useful educational tool on the prairies.

Probably the largest and most successful education effort was Operation Burrowing Owl which produced a great deal of interest due to HRH Prince Philip's participation at the initiation, and which has involved direct communication with landowners who have owls. More about Operation Burrowing Owl later.

Dr. Paul James, working around Regina, Ken de Smet in Manitoba, and Dr. Joe Schmutz in Alberta are monitoring the Burrowing Owl population changes and productivity in their areas. These data and data from Operation Burrowing Owl indicate greater population declines in the eastern parts of their range. They also suggest that mortality is quite high during the migration and winter areas.

At Regina the population has declined since the study began, but productivity is higher last year and we are hoping for a stable population this year. At least part of the decline appears to be due to low productivity due to a declining prey base, especially in 1989 after the 1988 drought. Unfortunately, the population is not showing signs of recovering, instead we think it is stabilizing at a new lower level. This suggests increased mortality is a long term problem.

Dr. James proposes to look at specific mortality factors, especially predation by Red Fox (*Vulpes vulpes*), this summer (1992). Also, research to be initiated in the spring of 1992 through the University of Saskatchewan will examine the factors affecting productivity, especially the effect of food supply. The research may show us ways to increase productivity.

PROTECTION AND MANAGEMENT OF NESTING HABITAT

Although there are unoccupied suitable habitats for Burrowing Owls, at present we also find them nesting in apparently marginal sites such as road ditches. Loss of good pasture habitats in key areas like the Regina Plains has been extensive and fragmentation of the remaining habitat into small parcels is also impacting on the owl. Dr. James will speak on this topic in the session on habitat fragmentation.

The majority of Burrowing Owls on the prairies nest on private lands. Hence direct contact with landowners is very important in maintaining habitat. In Manitoba, agreements and leases have been signed with some landowners. In Saskatchewan and Alberta, Operation Burrowing Owl is the prime habitat protection mechanism. Under this program, landowners volunteer to maintain the Burrowing Owl nesting habitat in return for recognition, in the form of a gate sign, and an annual newsletter. Landowners also report on their owl population each year.

Since Operation Burrowing Owl was initiated in 1987, 498 Saskatchewan and 226 Alberta landowners have enroled to protect Burrowing Owl nesting areas. In 1991 these areas supported 647 and 357 pairs respectively. In addition the program through brochures, signs, newsletters, and other publicity has greatly increased awareness of the Burrowing Owl as a threatened species.

The recovery team has also identified that current agricultural policies and subsidies strongly encourage farmers to break grassland areas. In the past year programs such as Gross Revenue Insurance Plan, crop insurance, and transportation subsidies effectively pay a farmer in Saskatchewan $40 for each acre he cultivates. Because Burrowing Owls tend to nest on arable lands, these subsidies are a strong impediment to retention of Burrowing Owl habitat. This is of course a concern for other species as well. As a recovery team we have therefore identified our concerns in hopes of contributing to the search for a better solution for wildlife and our farmers.

A very interesting initiative led by Dr. Geoff Holroyd of the Canadian Wildlife Service is use of satellite imagery to identify Burrowing Owl habitat. Initial research has shown that areas of grassland used by ground squirrels are identifiable by satellite. Because of the use of Richardson's Ground Squirrel (*Spermophilus richardsonii*) holes by Burrowing Owls, this technique may also identify Burrowing Owl habitat. Research to determine whether this will work and is applicable outside the initial experimental area is now underway.

POPULATION MONITORING

Designing recovery efforts requires knowledge of the status of the population. To achieve this the small populations in Alberta and British Columbia are censused directly.

In Saskatchewan and Alberta we maintain files of locations where owls are reported each year. In addition, landowners in Operation Burrowing Owl are telephoned and report the number of owls on their property.

At Hanna and around Regina population changes on study blocks are monitored each year.

A standardized survey is discussed and last year Dr. Joe Schmutz experimented with call backs as a survey technique. However, the large areas to be covered make a range wide survey very difficult unless we can define smaller potential search areas, perhaps using satellite imagery. However, the current monitoring is clearly showing the direction the population is moving if not the absolute numbers.

POPULATION MANAGEMENT ON MIGRATION AND WINTER AREAS

One of the large problems with Burrowing Owl management is that we do not know where they spend the winter. We really do not have any band recoveries from what we consider the winter period. We suspect our owls are wintering in Mexico.

Several ways of confirming this are being investigated. We have worked with Mexicans to identify areas where there are Burrowing Owls in winter. We are investigating use of DNA matching to see if we can identify our population in the winter. In addition, we hope to initiate banding projects in Mexico, to see if those wintering owls do come to Canada where there might be a better chance of a band recovery.

ELIMINATE NEGATIVE EFFECTS OF PESTICIDES

As grasshoppers and mice are principle foods of the Burrowing Owl we were concerned about the impact of pesticides and rodenticides on the species. Research has been conducted to look at both potential problems.

Research by Dr. Paul James indicates that Burrowing Owls are not affected when ground squirrels are poisoned around them. This of course does not mean there will never be secondary poisoning, but at least in a series of monitored colonies there was not.

Research on grasshopper spray showed a different result. One chemical, Furadan, was shown to affect brood size and nest success when sprayed near nest burrows (Fox et al. 1989). As a result of this work Agriculture Canada has prohibited use of Furadan within 250 metres of a Burrowing Owl burrow.

RELEASE PROGRAMS

British Columbia has re-established a Burrowing Owl population by releasing owls obtained from adjacent states and captive breeding. Manitoba has also been releasing Burrowing Owls to supplement the small population there. Owls for the Manitoba release were obtained from Saskatchewan until 1991, when owlets were captured in North Dakota. A declining population in Saskatchewan made it desirable to obtain owls from elsewhere so as not to stress the donor population.

The British Columbia experience shows that releases can work. There has been less success in Manitoba, in part because the returning owls do not home precisely to the release areas but spread widely. Hence owlets released in Manitoba might be settling in North Dakota or Saskatchewan.

CONCLUSION

We have been working on these six goals for a couple of years now. Unfortunately, the Burrowing Owl population is still on a down trend. A fragmented habitat and relatively high mortality rates, especially off the breeding grounds, are significant concerns. We would really like to know where these owls winter and in general, many questions about the problems facing this owl remain. Fortunately the population is relatively stable in some areas and even showed an increase in the Wood Mountain area last year. I don't expect this species to disappear in the next few years, but neither are its problems fully understood or resolved.

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THE BIOLOGY OF PRAIRIE BATS

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INTRODUCTION

Of all the organisms that inhabit the prairies, bats are not usually the first ones to come to mind and yet they are a significant and important component of the prairie fauna. Of the 19 species of bats recorded in Canada, nine are found in the prairie provinces (Table 1). The most common of these, and the ones the public comes in contact with the most, are the Little Brown Bat (*Myotis lucifugus*) and the Big Brown Bat (*Eptesicus fuscus*). However, if there is a species that could be considered characteristic of the prairies, it would be the Small-footed Bat (*Myotis ciliolabrum*) which inhabits the arid regions of western Canada including the short grass prairies of Alberta and Saskatchewan (van Zyll de Jong 1985). As with many of the prairie bats, there is remarkably little known regarding the biology of Small-footed Bats. Even for species that are well studied elsewhere, such as the Little Brown Bat, information about the biology of prairie populations is scarce. More than anything else, it is this lack of information that hinders conservation efforts for prairie bats.

MIGRATION VERSUS HIBERNATION

Prairie bats fall into two major categories according to how they deal with the cold temperatures and lack of food (insects) during the winter. Three species migrate south for the winter while the other six hibernate (Table 1). The migratory species, Hoary (*Lasiurus cinereus*), Red (*L. borealis*), and Silver-haired Bats (*Lasionycteris noctivagans*), are amongst the most widespread species of North American bats and yet, due to their solitary habits, we know very little about them. They migrate north into the prairies and boreal forest in May and June and return south in August and September (Barclay 1985a). Silver-haired Bats, in particular, are often encountered by the public at these times (Schowalter 1979). In all the migratory species, males and females appear to migrate at different times, although in Hoary Bats the prairie population may consist almost exclusively of females coming north to bear their young since males are rarely caught (Schowalter 1979, Barclay 1985a).

All three migratory species roost in trees, silver-hairs apparently in crevices in bark (Barclay et al. 1988), reds and hoaries in the foliage (Barclay 1985a, van Zyll de Jong 1985). For this reason much of the prairie population of these species may migrate through the area to forested regions to the north. Those individuals that remain in the prairies undoubtedly rely on treed areas for roosts. For this reason maintaining treed areas along rivers and around farm sites is particularly important in prairie bat conservation efforts.

Table 1. Species of bats from the prairies.

Species	Common Name	Hibernation/ Migration	Colonial/ Solitary
Myotis lucifugus	Little Brown Bat	H	C
Myotis volans	Long-legged Bat	H	C
Myotis septentrionalis	Northern Long-eared Bat	H	C
Myotis evotis	Long-eared Bat	H	C
Myotis ciliolabrum	Small-footed Bat	H	C
Eptesicus fuscus	Big Brown Bat	H	C
Lasionycteris noctivagans	Silver-haired Bat	M/H	C?
Lasiurus borealis	Red Bat	M	S
Lasiurus cinereus	Hoary Bat	M	S

The six species that hibernate may also make seasonal movements out of the prairies, in their case to find suitable hibernacula. Hibernating bats require sites that provide stable, cold (approximately 2 to 6^{0} C), humid conditions and these are usually only found in relatively deep caves and mines. Although there are a few small hibernacula known in central Manitoba (B. Koonz, pers. comm.), sites within the prairies are rare (Schowalter 1979). The majority of bats most likely move north, east, or west to find suitable places to hibernate and this obviously broadens the geographical scope when dealing with prairie bat conservation. In Alberta, for example, male Little Brown Bats are common in the mountains during the summer (Barclay 1991), while colonies of females are most common further east, in the prairies (Schowalter et al. 1979). Females move into the mountains in the fall, presumably heading for hibernacula. Small-footed Bats, which are common in the arid areas of south eastern Alberta and south western Saskatchewan, may hibernate in these areas if deep enough rock crevices are present (Schowalter and Allen 1981).

Hibernating bats put on fat during the late summer and early fall and begin hibernating in late August or September. During the seven to eight months of hibernation, individuals periodically (every four to six weeks) arouse briefly to urinate and move position within the hibernaculum. However, they must survive on the fat reserves they start with in the fall as no feeding takes place. Undisturbed hibernation sites are thus crucial in preserving bat populations (see Brigham, this volume).

SUMMER ACTIVITIES

While Hoary and Red Bats are solitary during the summer, with females and their young roosting separately from other such family groups, individuals of the other species are colonial (Table 1). Colonies consist almost exclusively of adult females and their young. The activities of males are poorly documented, although they play no role in raising the young and are likely nomadic, roosting alone or in small groups in rock crevices, hollow trees, and buildings (Schowalter et al. 1979).

In the prairies, colonies of females form in May and, depending on the species, may consist of anywhere from a few individuals up to several hundred or thousand (as in Little Brown and Big Brown Bats). Natural colony sites include hollow trees (Barclay and Cash 1985) and rock crevices (Tuttle and Heaney 1974). We know more about colonies in buildings, however, and these are known primarily for Big Brown and Little Brown Bats (Schowalter and Gunson 1979, Schowalter et al. 1979). Maternity colony sites offer protection from the environment and predators and are usually warm, thus reducing the amount of energy females and young must spend maintaining a high body temperature (Barclay 1982, Kunz 1982). Adult, and probably juvenile, females return to the same maternity roosts each year and these sites thus again constitute vital resources which need to be protected from disturbance.

REPRODUCTION

For the hibernating species, mating takes place during the fall and winter at hibernacula (Thomas et al. 1979). Females store sperm until they leave hibernation in the spring, at which time fertilization takes place. Nothing is known regarding the timing of mating in migratory species although females arrive in the prairies already pregnant. Births for all species occur in June and early July, depending to some degree on spring weather since cold, wet conditions cause pregnant females to enter torpor thereby delaying parturition (Racey 1973).

The reproductive rate of all bats is extremely low and most species produce only a single young per year (Table 2). The small litter sizes of bats mean that populations cannot respond rapidly to improved conditions and recovery from population declines is relatively slow, an important characteristic to keep in mind in any conservation effort.

Female bats nurse their own young and recognize them through a combination of olfactory and acoustic signals (Fenton 1985). The young first fly when they are three to five weeks old and virtually fully grown (Burnett and Kunz 1982). For young of hibernating species in particular, the late summer and early fall is then crucial since they must not only learn how to fly and forage, but also must put on fat before entering hibernation. As it is, juveniles enter hibernation significantly lighter than adults and suffer considerable mortality through the winter due to starvation (Keen and Hitchcock 1980, D.W. Thomas, pers. comm.). If they survive their first winter, however, bats have long lives and Little Brown Bats have been known to survive for over 31 years in the wild (Tuttle and Stevenson 1982).

Table 2. Characteristics of prairie bats.

	Mass (g)	Litter Size	Summer Roosts	Diet
Little Brown	8	1	Buildings, Hollow trees	Midges, mosquitoes
Long-legged	8	1	Rock crevices, Hollow trees, Buildings	Moths, dipterans
N. Long-eared	7	1	Trees	Various small insects
Long-eared	7	1	Rock crevices, Hollow trees, Buildings	Moths, dipterans
Small-footed	5	1	Rock crevices	Various small insects
Big Brown	18	1-(2)	Buildings, Hollow trees,	Beetles, other large insects
Silver-haired	11	2	Hollow trees	Midges, mosquitoes
Red	13-16	1-4	Foliage	Moths, beetles, dipterans
Hoary	25-30	2	Foliage	Moths, beetles

FORAGING AND DIET

All the prairie bats are strictly insectivorous and all capture prey while on the wing. The two long-eared species—Long-eared (*Myotis evotis*) and Keen's Bat (*M. septentrionalis*)—however, are also adept at capturing insects from the ground and vegetation (Faure and Barclay 1992, P.A. Faure, pers. comm.). This provides these bats with an additional source of prey and may allow them to inhabit areas in which strictly aerial hunters are precluded, such as areas where cool ambient temperatures reduce the availability of flying insects (Barclay 1991). Aerial insects are detected using echolocation while prey-produced sounds and/or prey movement are used by the gleaning bats to detect prey on surfaces (Faure and Barclay 1992).

Most of the bats found in the prairies emerge to forage approximately 30 minutes after sunset (Barclay 1985a, 1985b, Saunders and Barclay 1992) and the greatest foraging activity occurs in the following couple of hours. During mid-summer, lactating bats may have several foraging bouts, each lasting less than an hour, with a second peak in activity just before sunrise. At other times, especially when ambient temperature falls below about 15°C, bat activity is low during the middle of the night. For most species, foraging does not occur at ambient temperatures below 10°C or in heavy rain (e.g., Barclay et al. 1988).

Foraging habitats vary considerably within species although there are some clear species differences. The larger bats, big browns and hoaries, are fast fliers and forage in open areas above fields, trees, or bodies of water (Barclay 1985b, Brigham and Fenton 1991). Agricultural areas are favoured by hoaries in at least some areas (Barclay 1985b, 1989). The smaller species are more manoeuvrable and can forage closer to the ground or to obstacles such as trees. Little Brown Bats are especially common foraging low (< 1 m) over calm bodies of water where insects tend to be abundant (von Frenckell and Barclay 1987, Saunders and Barclay 1992). Availability of water may thus restrict the distribution of this species and conservation of sloughs and small creeks is likely important in maintaining Little Brown Bat populations. The long-eared species forage primarily amongst trees and other vegetation, presumably due to their gleaning habits (Barclay 1991). Street and yard lights in rural areas can be focal points for bat foraging activity due to the aggregations of insects around the lights.

The diet of prairie bats also varies considerably (Table 2) and most species take a wide range of prey (Barclay 1985b, 1991, Brigham and Saunders 1990, Saunders and Barclay 1992). Little Brown Bats consume large numbers of dipterans, including mosquitoes, due to their habit of foraging over water (Barclay 1991, Saunders and Barclay 1992). Moths are a common dietary item of many species (Table 2), while big browns and hoaries have large, powerful jaws and include many beetles in their diet (Barclay 1985b, Brigham and Saunders 1990).

Since bats probably consume whatever insects are available, within certain size limits, in agricultural areas pest species that fly at night are undoubtedly subjected to considerable predation pressure if bats are present. Even non-reproductive bats consume up to one-half their own mass in insects per night. For a Little Brown Bat this would amount to approximately 400 mosquito-sized insects! During lactation, it is estimated that a female must consume more than her own mass per night to keep up with the demands of her young (Barclay et al. 1991). The potential for bats to act as insect-control agents is thus immense, and even moderately sized colonies may consume tens of thousands of insects per night. Just the presence of bats may reduce the abundance of some pest species. Many moths, for example, have ears that detect the echolocation calls of bats, causing the moths to move out of the area. Experiments demonstrated that playing bat-like sounds over corn fields reduced the abundance of corn borers because the adult moths avoided the experimental fields.

CONCLUSIONS

Although the above information might give the impression that we know a lot about the biology of prairie populations of bats, the opposite is true. Most of our information on North American bats comes from a few species studied almost exclusively in eastern Canada and the United States. Although the prairies have some of these same species, the unique aspects of prairie habitats and climate undoubtedly have profound influences on many aspects of bat biology. Big Brown Bats, for example, have twin young in eastern North America but primarily single young in the prairies (Schowalter and Gunson 1979). Roost sites, diets, and foraging behaviours all vary geographically within the same species (e.g., Barclay 1985b, Brigham and Saunders 1990, Brigham 1991). The bottom line is that we can not assume that what applies to eastern populations or species necessarily applies to prairie populations or species. The following are some of the key pieces of information we still require if we are to make educated decisions regarding prairie bat conservation.

1. Information on where prairie bats hibernate, or at least what their seasonal movement patterns are, is needed to delineate the geographical boundaries within which prairie populations exist. Conservation only in the prairies during the summer may be futile if disturbance to hibernation sites goes unnoticed.

2. The natural roost sites of most species are virtually unknown. Older trees with hollows or other large crevices may be required for some species, for example, while rock crevices may be important for species such as Small-footed Bats.

3. We have virtually no information regarding the population densities of the non-colonial species. We need to know what proportion of those that migrate into the area actually stay to breed rather than continuing north. The habitat requirements of these species are also poorly documented.

4. Information regarding Small-footed and Long-eared Bats is particularly lacking. Summer roost site and hibernation site requirements, breeding biology, and foraging habitats all need to be better understood before we can attempt to implement logical conservation plans.

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RABIES IN INSECTIVOROUS BATS IN THE PRAIRIE REGIONS OF CANADA

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Rabies is one of the oldest recorded diseases. As early as 322 B.C., Aristotle described clinical signs in humans and dogs that undoubtedly are those of rabies infections. It is an acute infectious disease of the central nervous system caused by a virus, *Formido inexorabilis*, which can infect all warm-blooded animals. Rabies has a worldwide distribution and is absent only in a few islands or island continents. There are very few documented cases of survival of infected individuals of any species, that is, all infections are likely to be fatal. Transmission of the virus generally requires direct contact between infected and uninfected individuals, often by biting. Because of its potential impact on human health, agriculture, and economics, all verified cases of rabies in Canada must be reported to the federal Department of Agriculture.

It is within the above context that rabies has become one of the most feared but also misunderstood diseases. Overlay this with a general perception of fear and misunderstanding of bats and it is easy to see why many of the concerns and attitudes towards rabies in bats are out of proportion to reality.

This paper will provide a general overview of the disease as well as its known prevalence and distribution in insectivorous bats in the prairie regions of western Canada. Data were gleaned from the literature and from the files of Agriculture Canada to cover the time period from 1968 to 1989. Concerns and precautions with regards to human infections are presented. Public awareness is the key to maintaining perspective on the disease and its hosts.

Rabies was first recorded in Canada in 1819 when the Governor General of Canada was bitten by his pet dog (or fox?) and subsequently died of rabies (Tabel et al. 1974). There were few reports of rabies in Canada prior to 1900; however, the number of cases increased steadily through the early 1900s. These cases primarily involved domestic dogs and a few wild canids. Concerted efforts to control the disease in the late 1950s and '60s essentially eliminated infections in domestic dogs. Currently, virtually all rabies in Canada is maintained in wildlife reservoirs.

Insectivorous bats, that is, those bats which feed exclusively on insects, are one of the wildlife reservoirs of rabies. The disease was first identified in insectivorous bats in 1953, although it is likely the virus had been overlooked for many years (Baer 1975). Since then it has been identified in 30 of 39 bat species found in North America (Constantine 1979) and in most provinces and states. However, the pattern of infection and transmission of the virus appears to be distinctly separate from that in terrestrial species (such as skunks and foxes). As an extreme example, a few cases of rabies in bats are recorded each year in British Columbia, yet rabies is not established in any terrestrial species within the province (Pybus 1986a). In contrast, 2000 to 3000 cases are recorded annually in Ontario but, on average, only 30 rabid bats are recorded each year (Agriculture Canada, unpublished data).

While rabies in terrestrial species tends to sweep through susceptible populations in successive waves, rabies in insectivorous bats is much more localized and often is restricted to individual solitary bats or a few infected individuals in a colony. Transmission may occur more often during normal aggressive or grooming behaviours than by an induced hyper aggressiveness as seen in carnivores (Baer 1975). Refined techniques of monoclonal antibody tests can distinguish bat sources of virus from terrestrial sources of virus (Smith et al. 1990) and further support the suggestion that rabies cycles independently in bats, with very little overlap with the virus in other species.

Rabies has been identified in bats in each of the three prairie provinces (Table 1). Similarly, it is enzootic (occurs naturally) in bats throughout Canada (except the maritimes) and in many states in the United States. The pattern of infection appears similar throughout North America: a few infected individuals are reported each year in most areas; infected individuals often are distributed widely; the majority of cases are reported June through September, with a preponderance in August and September; and a variety of colonial and solitary species are involved (Constantine 1967, Schowalter 1980, Pybus 1986a, Rosatte 1987).

Table 1. Prevalence of rabies in bats submitted by the public in the prairie region of Canada from 1968 to 1989.

	Percent infected (sample size)		
	Alberta	Saskatchewan	Manitoba
1968-1977	4.6 (1842)	6.2 (421)	5[a]
1978-1984	4.0 (1347)	3.5 (661)	2[a]
1985-1989	2.9 (1075)	5.0 (760)	1 (47)

[a] Number of infected bats (sample size not available)

In the prairie provinces, an average of ten to twelve rabid bats are recorded each year. Big Brown Bats (*Eptesicus fuscus*), make up the highest proportion of rabid bats (50-60%); however the rate of infection is relatively low (5-10%) (Pybus 1986a). This species often uses maternity roosts (summer colonies) in buildings shared with people and therefore is likely to be seen and collected. Big Brown Bats also are the only species to hibernate in buildings in the prairie region. Normally, hibernating bats are hidden from public view; however, in periods of rapid temperature changes (either increasing or decreasing), conditions within buildings may become unsuitable and Big Brown Bats become active and seek other sites to sleep. At this time they may be seen by the public and submitted for rabies testing.

Little Brown Bats (*Myotis lucifugus*) are by far the most common bat species throughout the prairie regions. This species uses maternal colonies in a wide variety of buildings and they are the bat that people are most likely to see in houses, in barns, along rivers and streams, and around most lakes and sloughs (Pybus 1986b). They also are the species most likely to be submitted for rabies testing and yet they are the species least likely to be rabid (Constantine 1967, Schowalter 1980, Pybus 1986a).

We know very little about rabies in solitary forest-dwelling species of bats. Hoary Bats (*Lasiurus cinereus*), Silver-haired Bats (*Lasionycteris noctivagans*), and Red Bats (*Lasiurus borealis*) migrate north across the prairies in late spring/early summer, spend the summer in deciduous and conifer cover in the aspen parkland and boreal ecoregions, and then cross the prairies again in August and September (van Zyll de Jong 1985). As such, they are rarely seen by people and thus, infrequently submitted for rabies testing. About all we can say is that some rabid individuals of these species are recorded.

One of the major problems associated with understanding rabies in bats concerns bias in the sample. Normally, bats are inactive and inconspicuous during daylight hours and rarely are seen. However, bats submitted for rabies testing usually are collected during the day. Many of these bats are found on the ground, making much noise, and unable to fly. They are perceived by the public as being sick or wounded (often by pet cats) and submitted to Agriculture Canada for rabies testing. The behaviours of these bats are not normal and the sample is unlikely to be an accurate reflection of the infection rate in the population of bats as a whole. Random samples of bats collected within roosts indicate a much lower prevalence of the virus. Rabies was detected in only one of over 2000 bats collected during surveys by Alberta Fish and Wildlife (Pybus, unpublished data).

People should be warned not to handle bats, similar to the warnings against handling any wild animal. Bats found on the ground should be removed (without handling them directly) in order to prevent them from being picked up by a child or a pet. This is accomplished easily by wearing gloves or by using a stick to push the bat into a container. Once collected, such bats should be submitted to a veterinarian or wildlife officer along with a request to have the animal tested for rabies.

Although humans are susceptible to bat rabies, there are very few cases of infection: in Canada, only 21 cases of fatal rabies infection in humans have been recorded. Of these, only 3 were associated with rabies from bats. However, medical precautions should always be taken when there is any suggestion that someone may have contacted a rabid bat.

Anyone bitten by a bat should contact a physician as soon as possible. Also, if possible, collect the bat so it can be submitted for rabies testing. If the bat is collected and if the bat does not have rabies, no further action is warranted. But if the bat does have rabies, post-exposure vaccine will be administered. The treatment involves up to five intramuscular injections into the arm, similar to getting flu shots. If the bat is not collected, the physician will advise that the immunization shots be given as a precaution, even though the chances of the bat actually having rabies are very low.

With appropriate precautions when handling wild animals and with the availability of pre-exposure and post-exposure immunization, rabies infection in humans can be avoided. However, if these steps are not taken and an infection becomes established in the central nervous system, rabies remains a fatal disease. Thus, the bite of any wild animal should be treated seriously.

Our concerns and fears of rabies in bats appear to stem from early information about rabies in vampire bats in the tropical regions. The prevalence of rabies in haematophagous species (blood-feeding species) is considerably higher than that in insectivorous species. The most constructive thing we can do for the conservation of bats in prairie regions, or in any habitat, is to dispel the fear and concern that the public has for bats and for rabies. This is entirely in line with goal #9 of the Prairie Conservation Action Plan (World Wildlife Fund 1988).

Public information regarding bats should focus on the fact that all bats are not the same and that the species present in the prairie regions of Canada are integral and beneficial elements of the ecosystem (see articles by Barclay and Brigham, this volume). The data summarized in this paper indicate that rabies is an uncommon infection in prairie bat species. Even bats which are acting abnormally are unlikely to be infected with rabies.

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THE IMPLICATIONS OF ROOST SITES FOR THE CONSERVATION OF BATS

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Although it should go without saying that the conservation of all prairie species is important, further justification is often required to convince the general public that bats should not be exterminated as pests. All nine species that occur in the prairie provinces are insectivorous and thus are important natural control agents of agricultural pests and biting insects, including mosquitoes (see Barclay this volume, Fascione et al. 1991). To satisfy their high metabolic rates (Kurta et al. 1989), insectivorous bats have voracious appetites resulting in the consumption of flying insects representing 50-100% of the bat's body mass nightly (Barclay et al. 1991)! Depending on the size of specific insect prey, this may mean between 600 and 1200 insects consumed by an individual bat on one night.

As for any species, the conservation of bats is only possible if the critical habitats and resources they depend on are protected. Bats depend on areas to forage and places to roost, and for some species, the proximity to standing water also seems to be important. For the purpose of this paper, I will concentrate on roost sites, since these sites are generally specific to bats. Foraging habitats used by bats are so diverse that discussing them in general terms is virtually impossible and the foraging flexibility exhibited by bats suggests that identifying specific sites would be difficult (e.g., Brigham 1991). Further, from a conservation standpoint, roost sites are vulnerable in that people represent the major threat to bats in these locations. Thus education can have a major impact on the protection and long term survival of these mammals (Tuttle 1988).

For the six prairie species which are year round residents (Big Brown Bat [*Eptesicus fuscus*], Little Brown Bat [*Myotis lucifugus*], Western Long-eared [*M. evotis*], Western Small-footed Bat [*M. ciliolabrum*], Northern Long-eared (Keen's) Bat [*M. septentrionalis*], and Long-legged Bat [*M. volans*]), two different roost sites are required during the year; one for hibernation during the winter and one for summer maternity colonies. The critical summer roosting sites for prairie populations of migratory bats (Hoary [*Lasiurus cinereus*], Red [*L. borealis*], and Silver-haired [*Lasionycteris noctivagans*]) are likely most common in riparian forest. It is probable that the maintenance of introduced trees in urban areas and as windbreaks has helped these species considerably, however, there is little data on the effect of urban environments on these migratory bats.

HIBERNATION SITES

Hibernating bats arrive at hibernation sites in autumn (late July to November). Prior to entering hibernation, bats must accumulate up to 40% of their summer body mass as fat to use as an energy supply throughout the winter. If these reserves are depleted before warm spring weather and the emergence of flying insects, the bat starves. Bats seem to select hibernation sites on the basis of temperature and humidity, but the precise means by which they do this remain unknown (e.g., Nagel and Nagel 1991, Tuttle 1991) and each species has its own optimal conditions. The site must be cool enough to allow metabolism to remain low, yet warm enough to prevent freezing. This generally means a range between 0° and 10°C. Moisture in the form of humidity may be even more important than temperature to hibernating bats. Natural arousals, which probably account for 80-90% of the total drain on fat reserves through the winter are mediated by water loss (Thomas et al. 1990). Bats occupying more humid sites should be able to remain torpid for longer periods than animals in dry sites.

Where prairie bats hibernate is mostly a mystery. It is known that Big Brown Bats can hibernate in buildings that offer the right conditions (Brigham 1987). However, in most cases bats use abandoned mines, natural caves, or deep rock crevices. In all likelihood, most prairie bats must migrate to find these sites (Schowalter 1980). It may be that much of the fall migration is northward to the Canadian Shield, where potential sites are likely more common. Regardless of the migration destination, it is clear that we cannot fully protect prairie bats by focusing only on prairie sites. We must retain a broader geographical perspective.

Bats are most vulnerable during hibernation, yet protecting them at this time is relatively simple. The most frequent problem is human disturbance at hibernation sites. Requiring up to an hour to arouse when disturbed, bats cannot fly away from danger and vandals can easily destroy hundreds or thousands at sites with large numbers. Even more unfortunate are the results of inadvertent disturbance by cave/mine explorers who are unaware of the effects they have on bats. It is well documented that human entry into a hibernation site causes many bats to arouse. Each time a Little Brown Bat arouses, it expends sufficient body fat to have lasted for 67 days of uninterrupted hibernation (Thomas et al. 1990). Thomas and his colleagues estimate that three extra arousals beyond the normal number can cost a Little Brown Bat its life. The simple solution is to prevent human access to hibernation sites during the winter. It is fine to enter these sites in the summer when they are not used by bats. We also need to reconsider the strategy of using explosives to blast old mines shut for safety reasons. Caves or mines can be gated in a way that allows bats to come and go but keeps people out (Thorne 1990). Gating allows bats to continue to use sites, solves the safety problem, and, in the case of caves, can also restrict human access at certain times (e.g., winter) of the year. As usual, the best prevention is through education. People who are informed of the inadvertent harm they may cause wildlife will almost invariably cease the activity causing the problem.

SUMMER MATERNITY ROOSTS

The second essential roost habitat required by bats is a summer roost. These sites are essential to provide shelter from predators and inclement weather but, most importantly, to provide the appropriate environmental conditions for raising young. Bats have been documented to use every conceivable type of shelter including: trees (hollows, under bark, in foliage), rock crevices, animal burrows, abandoned mines, and buildings (Kunz 1982). Prairie bats are most often found roosting in hollows (trees, buildings; Schowalter and Gunson 1979, Barclay and Cash 1985) or the foliage of trees (Barclay 1984). Hollows tend to be exploited by female *Myotis* and *Eptesicus*, species that congregate in large maternity colonies to bear and raise young. These sites are likely limited in number and are especially vulnerable to human disturbance. Roost temperatures tend to be extremely high (often 35°C in the daytime), a characteristic that promotes the rapid growth of baby bats. For most species, we have little knowledge of the summer roosting activities of male bats, but they likely roost solitarily or in small groups. Foliage roosting species such as Hoary and Red Bats are solitary, roosting singly or in small family groups comprised of a female and her young (van Zyll de Jong 1985).

Unless disturbed, there appears to be a strong degree of loyalty to roosting sites (both summer and winter) with individuals exploiting the same sites for many years (Brigham and Fenton 1986). This should increase our incentive to protect tree hollows and cavities that are known to be used by bats. However, the use of buildings as roosts, especially by Little Brown and Big Brown Bats, often brings bats into direct conflict with people. Large numbers living in the attic of a house is a nuisance that many people will not tolerate. Most colonies are small and particularly in well insulated buildings, may remain undetected for years. When guano accumulation, odors, or noise from large colonies necessitate a remedy, eviction and exclusion is the only safe, permanent solution (Barclay et al. 1980, Brigham and Fenton 1986, Saunders 1990). Lights, noisemakers, ventilation, and various chemicals including mothballs are simply not effective (Hurley and Fenton 1980, Laidlaw and Fenton 1971). In fact, poisons usually create worse problems than those they are meant to solve. Poisoning increases the chance of contact between bats and people and weakened bats may be more susceptible to diseases such as rabies (see Pybus, this volume). Further, any poison that kills or disables bats will likely be detrimental to human health. Exclusion eliminates the problem, but does not kill the animals. Killing is strongly discouraged both because it is unnecessary, but also because it is not a permanent solution to the problem. Unless the access areas used by bats are closed off, the building will likely be recolonized in the near future.

If bats must be excluded from a building, the first step is to determine the access site(s). By watching the building at dusk as the bats exit to feed, they will "show" how they are getting in and out. Close inspection during the daytime will reveal the holes or cracks (often less than 1 cm wide) being used. Once the exits have been located and the number of bats that emerge counted, bats can be excluded by sealing cracks with screening or other light building materials (Barclay et al. 1980). Unlike rats and squirrels, bats cannot chew their way through these materials. Ideally the access points should be sealed in winter when the bats have left the structure to hibernate (generally October to April). If it is necessary to exclude bats in the spring or fall, do so only after all the bats have left the roost at night to feed. Do not close off openings from mid-June until the end of August as this is when flightless young are present and excluding mothers will result in the death by starvation of the young.

Bats are very adept at finding and using alternative entrances to a preferred roost and it is important to seal all potential access points (Brigham and Fenton 1987). Presumably, bats select particular buildings because of the optimal conditions they provide; therefore, it is not surprising that they will be persistent in their efforts to gain access. Finally, before attempting exclusion, warn your neighbours. For excluded Big Brown Bats at least, the animals often take up residence in the nearest structure, meaning your neighbour's house (Brigham and Fenton 1987).

It is possible to invite bats to your neighbourhood and enjoy the positive aspects (e.g., insect control) without having to share your house with them. Bat houses are becoming more popular in North America and can be constructed or purchased for a modest cost. Plans for a bat house developed by Matthew Saunders (Bat Check, Box 1243, Kingston, Ontario K7L 4Y8) are shown in Figure 1. Saunders also sells these structures preconstructed. Plans and preconstructed bat houses can also be purchased from Bat Conservation International (Box 162603, Austin, Texas 78716). Factors critical for the success of these houses include: their size and shape, roughness of roosting surfaces, and the distance from foraging areas. All inner surfaces should be rough or horizontally grooved to ensure that bats can get a foothold. Avoid using chemically treated lumber as many wood preservatives are toxic to bats. Do not paint, stain, or varnish the structure because odors from these coatings will discourage bats. Mount the house three to six metres above the ground on south facing aspects in areas that offer some protection from the wind. Bat houses near water are probably most likely to be successful.

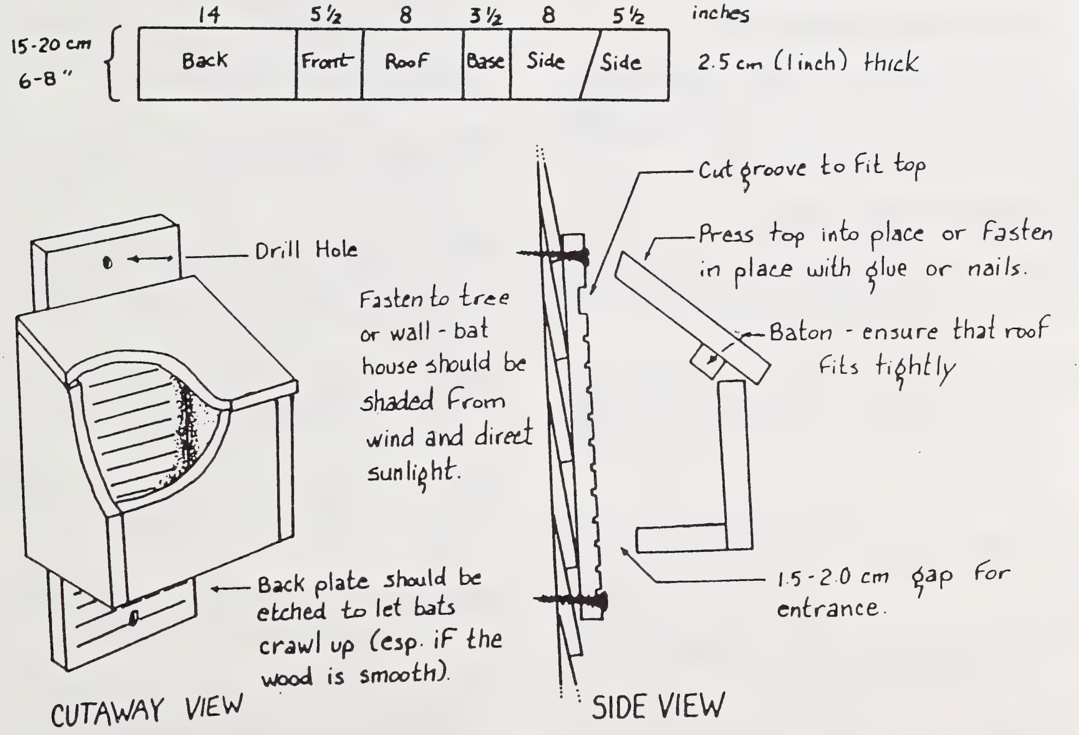
14
5½
8
3½
8
5½
inches
15-20 cm
6-8"
Back
Front
Roof
Base
Side
Side
2.5 cm (1 inch) thick
Drill Hole
Fasten to tree or wall - bat house should be shaded from wind and direct sunlight.
Cut groove to fit top
Press top into place or fasten in place with glue or nails.
Baton - ensure that roof fits tightly
Back plate should be etched to let bats crawl up (esp. if the wood is smooth).
1.5-2.0 cm gap for entrance.
CUTAWAY VIEW
SIDE VIEW

Figure 1. This small bat house may house up to 30 bats at a time. It can be modified to hold more bats by increasing the width of the board and using the same dimensions for the other parts. Other designs can be used, but the best designs have an entrance no more than 2.0 cm wide and no longer than about 15 cm from side to side. If the distance between the back and front of the house is increased, include a dividing wall in the centre. Bats prefer relatively cramped space and the divider will increase the capacity.

Finally, be patient, most bat houses are not occupied for a least a year and sometimes only after two or three years. As with bird houses, some are never occupied for one reason or another. One strategy that seems to work is to put up bat houses at the same time as the exclusion of a colony from a nearby building is attempted. The bat houses become a readily available alternative roosting site.

In conclusion, I hope I have illustrated that we really can do something to protect and conserve the bats that are found in the prairies. Usually some simple information and eduction will make all the difference. Although it is perhaps overly optimistic to expect the majority of people to become "bat lovers," it should be possible to achieve a situation where no one will cause intentional harm and we can prevent the unintentional damage due to a lack of information. This is probably the greatest threat to bat populations.

ACKNOWLEDGMENTS

I thank Ryan Csada and Robert Barclay for their constructive comments on the manuscript and an operating grant from the Natural Sciences and Engineering Research Council for financial support.

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AN UPDATE ON THE SWIFT FOX REINTRODUCTION PROGRAM IN CANADA

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INTRODUCTION

The Swift Fox (*Vulpes velox*) Reintroduction Program began as a private project when Miles and Beryl Smeeton established a wildlife reserve near Calgary, Alberta and imported two pairs of Swift Fox from Colorado, United States in 1973. This parent stock subsequently bred and raised young and from these beginnings grew a project that developed into a major program involving four university/federal/provincial groups (Canadian Wildlife Service [CWS], Alberta Fish and Wildlife [AFW], Saskatchewan Natural Resources, University of Calgary) and numerous non-government organizations (Calgary Zoo, Wildlife Reserve of Western Canada [WRWC], Moose Jaw Wild Animal Park, Edmonton Valley Zoo, Swift Fox Conservation Society, World Wildlife Fund [WWF], Petro Canada, Esso Resources, Canadian National Sportsman Show, Elsa Foundation, Grant McEwan Nature Foundation, Canadian Automobile Association). Earlier results of the Swift Fox program were summarized in this conference series (Herrero et al. 1991) and by Scott-Brown et al. 1986.

The CWS first became involved in 1978 when COSEWIC (Committee on the Status of Endangered Wildlife in Canada) classified the species as extirpated in Canada. From 1984 to 1989 the project was guided by a technical committee, which was replaced in April 1989 by a recovery team under RENEW (Recovery of Nationally Endangered Wildlife).

The mandate of the recovery team was to carry out a 3-year experimental program with the main objective being, "Is it feasible to reintroduce the Swift Fox back into the Canadian prairies." This objective has been approved by the Committee of Wildlife Directors of Western Canada (WDWC). When the recovery team was established it had available to it a wealth of information, obtained over the years by lengthy "trial and error research." It is important to recognize that without this field data, none of the information we now have on the responses of the foxes to different release techniques or environmental conditions would have been available. This database has stimulated new ideas which needed to be explored.

From 1983 to the fall of 1987 all releases of mainly captive bred foxes had been done by the soft release technique, i.e., holding foxes over winter in pens and releasing them the following spring or summer, whether they had successfully bred in the pens or not. In the fall of 1987 the first hard releases were attempted; releasing foxes directly into the natural prairie landscape (Carbyn et al., in press).

About 30% of all Swift Fox releases were radio collared in both hard and soft releases. Survival data was obtained. The program was expanded to include: 1) releasing more wild trapped foxes and comparing their survival with captive bred individuals; 2) releasing foxes in the spring rather than the fall to determine which time frame gives better survival; and 3) diversify release locations, choosing a release area which has more moisture and better habitat as a hedge against drought which had occurred in 1988 at the main release location.

After the 3-year experimental program, the data was evaluated to determine if reintroduction is feasible and to provide recommendations to the WDWC as to whether a full scale recovery program is possible (Carbyn et al. 1991).

SOURCES OF FOXES

Two sources of Swift Fox are available for reintroduction: captive bred and wild trapped from the United States.

Captive Bred

Four breeding facilities are producing Swift Foxes for release in Canada. They are: 1) WRWC, renamed in 1991 to Cochrane Wildlife Reserve, near Cochrane, Alberta; 2) Calgary Zoo, Calgary, Alberta; 3) Edmonton Valley Zoo, Edmonton, Alberta; and 4) Moose Jaw Wild Animal Park, Moose Jaw, Saskatchewan.

Cochrane Wildlife Reserve currently has 25 pens in use and can produce 60 to 90 young Swift Fox annually. Calgary Zoo houses 4 to 5 pairs and produces 15 to 20 foxes per year. Moose Jaw Wild Animal Park has 5 breeding pens and produces 15 to 20 foxes per year. Edmonton Valley Zoo has one display pair and produce 3 to 5 young yearly for the release program.

Wild Trapped from the United States

Swift Fox populations exist in substantial numbers available for trapping as far north as central Wyoming. From 1973 to 1991 a total of 107 Swift Fox have been imported from the United States. The breakdown by state is as follows: South Dakota - 13; Wyoming - 52; Colorado - 42. Excellent cooperation has been obtained from the Wyoming Game and Fish Department in 1990 and 1991.

RELEASE SITES

Totals released at various release sites are summarized in Table 1.

Border Area

The Alberta/Saskatchewan border area has a continental prairie climate characterized by cold, harsh winters, warm summers and low precipitation. The mean yearly precipitation is 340 mm (range 260 to 380 mm). The Short Grass Ecoregion has the warmest summer temperature in Alberta. The mean May to September temperature is 15°C (range 14.5 to 16°C). Winters are characterized by cold temperatures and relatively little snowfall. The mean December to February temperature is -10.5°C. The combination of low temperatures interspersed with warm thaws and little snow cover results in harsh winter conditions for vegetation.

The terrain of the area is generally flat to rolling except where bisected by numerous coulees and run-off channels. Elevations average approximately 1,000 m above sea level. Major habitat types in the study area include uplands, coulees, and badlands. The predominant vegetative association of the upland types is the Spear Grass (*Stipa comata*)-Blue Grama (*Bouteloua gracilis*) association. Vegetation in the coulee areas is variable. Slopes may be eroded or grassy, shrubs such as willow (*Salix* spp.), and Saskatoon (*Amelanchier alnifolia*) may be present. A Western Cottonwood (*Populus deltoides*) association is found in the Milk River Valley. Badland habitats are generally devoid of vegetation and only hardy species such as Greasewood (*Sarcobatus vermiculatus*), sagebrush (*Artemesia* spp.), prickly pear cactus (*Opuntia* spp.), Winter Fat (*Eurotia lanata*), and Salt Sage (*Atriplex nuttallii*) can survive (Reynolds 1983).

Although there are cultivated areas (hay and wheat fields) within the release area the primary land use is ranching. The area is generally remote and contains few inhabitants. The area is roughly circumscribed by: Cypress Hills to the north; Montana border to the south; Manyberries to the west; and Consul, Saskatchewan to the east.

Milk River Ridge (Knight/McIntyre Ranches)

This release area is located in southwestern Alberta roughly between Magrath to the north, Del Bonita to the south, Milk River to the east, and Cardston to the west. The elevation of the Milk River Ridge ranges from 1000 m in the east to approximately 1400 m to the west. The climate is considered to be inland continental characterized by cold winters and warm summers. Precipitation (500 to 550 mm) is almost double that of the Alberta/Saskatchewan border area. The Milk River Ridge is an area of transition from the mixed grass prairie to the fescue prairie of the south western foothills. In coulees and protected moist areas shrubs such as willow, rose (*Rosa* spp.), Silver-berry (*Elaeagnus commutata*), and Thorny Buffalo-berry (*Shepherdia argentea*) occur.

Table 1. Summary of the numbers, location, and number of radio collared Swift Foxes released during hard release programs in southern Alberta and Saskatchewan.

Summary of hard releases - 1987 to 1991

Year/Season of release	Alta./Sask. Border		Wood Mountain		McIntyre	
	# Released	# Collared	# Released	# Collared	# Released	# Collared
Fall 1987	57	18	-	-	-	-
Fall 1988	53	12	-	-	-	-
Spring 1989	-	-	-	-	28	14
Fall 1989	35	13	-	-	33	13
Spring 1990	28	27	-	-	-	-
Fall 1990	38	0	51	20	-	-
Spring 1991	-	-	29	28	-	-
Fall 1991	35	0	46	10	-	-
Site Total	246	70	126	58	61	27
Hard releases					433	
Soft releases					136	
Total					569	

This release area was chosen during a period of drought on the prairie. Higher moisture levels on the Milk River Ridge made it an appealing choice. Releases were discontinued in 1989 when a rabies outbreak occurred in the Striped Skunk (*Mephitis mephitis*) population and Alberta Agriculture had to set out a poisoning program to reduce threat of spreading the disease.

Wood Mountain

The Swift Fox release areas were selected after examination of potential sites across southern Saskatchewan and Alberta. The primary requirements sought were areas of continuous prairie of at least 500 to 800 km^2 and a population of American Badgers (*Taxidea taxus*) to provide holes. Prey abundance, moisture conditions, and winter severity were also considered when looking at possible review sites.

In Saskatchewan, the Wood Mountain area, the border area south of Cypress Hills, the Matador area and the Missouri Coteau near Old Wives Lake, and the area near the Great Sandhills were examined. Only the Border and the Wood Mountain area were judged large enough and suitable terrain for Swift Fox release. The release area is between the East Block and the West Block of Grasslands National Park, this offers some degree of permanency that the area will remain natural grassland habitat.

RESULTS AND DISCUSSION

Survival and Monitoring

From 1987 to 1991 there were 155 radio collared foxes hard released on the three release areas (Table 1). Since 1988 there were 33 wild (United States) Swift Foxes (captured in Wyoming or Colorado and translocated) hard released in Alberta and Saskatchewan. Since 1987 there have been 122 radio collared captive raised foxes hard released in Saskatchewan and Alberta. Of the 122 radio collared hard released captive raised foxes 41 were released in the spring, and 81 were released in the fall.

During the first six months post release, the captive raised fall released foxes survived significantly better than the spring released captive foxes. At the end of the twelve month period fall and spring released captive raised foxes had similar minimum known survival rates. Although the sample size is small for wild (United States) foxes released in the fall there is no obvious difference in minimum survival rates between spring and fall releases. It is clear that regardless of which kind of fox is released or when, it is the first three months that are the most critical. From three months to nine months the survival slopes of the spring released captive foxes and the wild (United States) foxes are almost identical except they have stabilized at different levels. This indicates that these two groups have probably developed similar survival mechanisms after the first three month adjustment period. The fall released captive raised foxes show a steep drop in survival for the first three months but stabilize at a higher level than spring released captive raised foxes, however, the decline to twelve month period is steeper than any other group. This appears to be a result of possible better conditions in the fall and foxes released at that time probably face more favourable conditions from September through November but are then presented with the rigors of winter. By the time winter sets in, those that have survived, will have found protective cover and a knowledge of their hunting terrain. These fall released foxes also display another slight drop in survival during the spring of the following year which puts them at a similar level of minimum known survival as spring released captive raised foxes at the end of twelve months.

When the data from 21 foxes wild born on the study area, wild (Canada), are included there is, as expected, no steep drop in the first three months after capture and the survival rate declines steadily over a 12 month period. At the end of 12 months the minimum known survival of the wild (Canada) foxes is actually lower than the wild (United States) translocated foxes. This may be due to the combination of juveniles and adults of various ages in the wild (Canada) component. The wild (United States) foxes were all a minimum of one year old when released and old foxes were imported for release to the study area.

There may be several explanations for the differential survival of fall and spring released captive raised foxes. The captive raised foxes released in the fall are mostly young of the year (five to six months old) compared to the spring released foxes which are all at least twelve months old. The young foxes may be much more flexible behaviourally, learning to capture prey and avoid predators earlier than the older foxes. The other main factor, which is not unrelated to the first, has to do with prey abundance and availability. For example, in the fall of 1987 there was tremendous abundance of grasshoppers. Captive raised foxes shortly after being released, were observed capturing grasshoppers. Field observations of scat contents revealed a very high percentage of grasshopper parts. As the foxes gained experience in hunting, the proportion of grasshoppers decreased and small mammal content of the scats increased. It is therefore, probable that the easily available grasshoppers provided both nourishment and learning experience for the young foxes. Foxes released in the spring do not have this opportunity and although there may be an abundance of other food sources they may not be available to an inexperienced fox. The most abundant source of prey in the spring in the Saskatchewan/Alberta release area would be young ground squirrels which are not very difficult to capture. However, Richardson's Ground Squirrel (*Spermophilus richardsonii*) distribution in the area is very spotty and may be unavailable to foxes inexperienced at catching them, also ground squirrels are not nocturnal. Foxes which hunt ground squirrels during the day are probably more exposed to predation.

Survival of Captive Raised Versus Wild Caught Foxes

Experimental releases using captive raised and wild caught foxes were simultaneously released in the spring (May) 1990 and spring (May) 1991. In the first release 14 and 13 foxes, respectively, were let go on a hard release. In 1991, 14 foxes from wild caught and captive raised groups, were released in a similar experiment. In both years, all foxes released were radio collared and movements monitored at regular intervals.

The experiment clearly indicated that survival of wild caught foxes was superior to captive raised foxes. Five out of 27 (19%) of the captive raised foxes were known to be still alive after three months. Seventeen out of 28 (61%) of the wild caught foxes were alive after three months post release. Six months after the release, 15% of captive raised foxes and 50% of wild caught foxes were still alive and after nine months figures were 7% and 43% respectively. In this experiment all captive raised foxes were young of the year, while wild caught foxes included all age classes.

This experiment did not test survivorship statistics of fall released wild foxes with fall released captive raised foxes. Not enough is known about whether or not foxes captured in late summer are old enough for release in fall, prior to when harsh weather conditions set in. After capture and transport from the United States to Canada, there is always a 30-day quarantine period to deal with. In any case, if spring conditions are less suited than fall conditions and spring released wild caught foxes are superior to fall captured captive raised foxes, then the conclusion that wild caught foxes are superior still is valid. More experimental work would be desirable, if funding were to permit.

Current Status (1991)

The Canadian free roaming Swift Fox population in the winter of 1991/1992 was estimated at a minimum of 225 (range 150 to 300) individuals (Carbyn et al., in press). All of these foxes are believed to have originated from the release program. Of the three release areas the Saskatchewan/Alberta border area has the greatest numbers of foxes. The information from the Milk River Ridge is very limited. Only one natal den was found in 1991 and very little sign observed. More data is needed for this area but we expect that there may be no more than ten or twelve foxes in the Milk River Ridge area.

The Wood Mountain release area is still under investigation. From current information we expect the population there to be less than fifty foxes (D. Hjertaas, in prep.).

The population of 150 to 250 foxes on the border area was estimated by two methods (capture/recapture and saturation trapping). These two methods are not entirely independent. The first method involved the saturation trapping of a township on the Alberta side of the release area. This township was chosen as a representative one (it also had reasonable access). The results were then extrapolated for the roughly 13 townships of what we have described as core range. From satellite photos we estimated there may be as much as 70 townships of potential Swift Fox habitat available. Excluding the 13 townships of core range there are 27 out of 70 for which we have some evidence of Swift Fox occurrence (sighting, radio locations, tracks, or other signs). Although we trapped 11 individual foxes on the township, we know from radio telemetry information that one fox had a home range which was primarily outside the township. From the information we feel an average density of eight per township for the 13 townships in the core area would be more appropriate. This gives an estimate of 104 foxes. The 27 townships surrounding the core may have a density of four foxes per township for an estimate of 108 foxes. We have virtually no information for the remaining 30 townships. However, given the information we have on dispersal we estimate a possible density of one fox per township. The total estimate is 242 foxes for the Saskatchewan/Alberta border area.

The densities on the Saskatchewan/Alberta border appear to be somewhat similar to densities in Wyoming as reflected by trapping success (Table 2). The overall 11% success in Wyoming is actually lower than for the border area at 13.5%. The slightly higher border area success may be due to us having some knowledge of where to trap certain individual foxes, otherwise techniques were similar. This is a crude comparison and is not meant to indicate that we have a large viable population in the Saskatchewan/Alberta border area, only that for the 13 townships of core range in Saskatchewan/Alberta densities are roughly similar to the Wyoming trapping area.

It seems evident that we have a small population of Swift Foxes established on the Saskatchewan/Alberta border area. On the basis of genetic considerations alone, a population of 50 individuals is adequate for the short-term survival of most species. However, given environmental stochasticity, especially on the short grass prairies, where environmental condition can be severe, a population of more than 50 may be required for short-term survival. For long-term survival a population of several hundred may be essential to maintain population viability (Mace and Lande 1991).

Table 2. A year-to-year comparison of trap night success of Swift Fox in the Saskatchewan/Alberta area and southeast Wyoming.

Area	Total trap nights	Captures	% Success
Sk./Alta. 1990/91	215	41	19
SE Wyoming 1990	172	19	11
SE Wyoming 1991	205	24	13
Sk. Alta. 1991/92	308	25	8
Sk./Alta. Township	185	11	6

In the broader North American context, Swift Foxes are not an endangered species. Restoration of the Swift Fox to the Canadian prairie landscape has therefore, become symbolic, focusing on the need for protection and restoration of impaired ecosystems. Habitat fragmentation in the great plains region to the south makes dispersal more difficult. Unsubstantiated reports of Swift Foxes within North Dakota, if proven correct, could bring the American population possibly within about 200 or so kilometres of the United States/Canadian border.

Other Potential Release Areas

Throughout the history of the Swift Fox program, release areas have been chosen by evaluating and comparing habitat suitability among potential sites. The earliest releases in the Lost River Ranch area were decided upon after Carlington's (1980) evaluation was refined by Reynolds (1983). Additional releases in the border area and the Knight/McIntyre areas were preceded by habitat evaluations completed by C. Mamo. The Wood Mountain site was chosen after comparison with other potential Saskatchewan sites by D. Hjertaas and W. Harris.

In each of these evaluations, the key factors considered were: size and security of available suitable habitat; prey availability, particularly rodents, grassland birds, and grasshoppers; and den site availability as indicated by ground squirrel and badger burrows.

Within Alberta, the Swift Fox Recovery Team and experienced field staff believe that additional suitable potential habitat for Swift Fox is available to the north and west. Priority areas are: the Canadian Forces Base (CFB) Suffield, the area between Brooks and Medicine Hat, and the grasslands north of CFB Suffield.

CFB Suffield has been evaluated by Carlington (1980) and Mamo (pers. comm.). In all evaluations this area showed significant potential, with some concern expressed over prey availability (small mammals) and the compatibility of adjacent land use (military exercises). With the recent announcement of the proposed National Wildlife Area with CFB Suffield, this area again shows potential as a future release area. Problems do exist in sections of the CFB leasehold where sand is a predominate soil condition. Such areas may not be suitable for denning.

It is interesting to note that several foxes have dispersed from the existing southeastern release areas to the vicinity of Brooks and Gem, Alberta. Also two reports of Swift Fox seen near Iddesleigh and Ralston are believed to be legitimate. These reports reinforces the assumption that this area may provide habitat which Swift Fox view as suitable.

Assuming the existing Swift Fox program continues and is successful in establishing a resident population throughout available habitat in current release areas, it will be important to identify the potential of additional grassland areas which could support Swift Fox. Over the next five years, the priority blocks should be evaluated, using existing criteria, and compared to proven high quality habitat in the border area. Upon completion of the current program, this data can be used as a key factor to determine if and where additional releases should be undertaken. In future, it may be possible and desirable to simply translocate foxes from a healthy viable population in southeastern Alberta to vacant suitable habitats further north and west.

ACKNOWLEDGMENTS

Reintroduction programs invariably tend to be associated with high publicity, often high risk ventures producing an extra amount of organizational stress. The human factor becomes paramount and we like to thank the literally "hundreds" of volunteers, participants, and cooperators. Obviously there is not enough space to recognize them all. H. Armbruster, B. Treichel, and K. Sturgess were active and effective field workers. Wyoming Game and Fish Department and their employees were most helpful in the acquisition of wild foxes. D.J. Fitzgerald and John Sharps helped in earlier fox acquisitions. Funding came from CWS, AFW, WWF Canada, Petro Canada, Esso Resources, Swift Fox Conservation Society, Alberta Recreation Parks and Wildlife, Canadian National Sportsman Show, Elsa Foundation, Grant McEwan Native Foundation, Canadian Automobile Association and through the auspices of the Swift Fox Conservation Society, a non-profit organization, funds from literally thousands of school children and other contributors were obtained from an "adopt-a-fox program." We would like to thank M. Regnier for typing the manuscript.

Various breeding facilities were very supportive in the program. In particular, we would like to acknowledge S. Black, M. Curtis, P. McDougall, S. Mianka,

J. Michie, P. Rhodes, C. Smeeton, M. Smeeton (deceased), and G. Tarry. Ranchers throughout the area were supportive and interested in the project. We want to particularly thank the Moorehead's, Piotrowski's, and the Saville's. The captive breeding program involved employees, volunteers, and enthusiasts from all over Canada and some from Europe and the United States. Staff from captive facilities were involved in various stages. Calgary Zoo staff were supportive in providing veterinarian services and kept records of the captive population.

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A REVIEW OF THE FILM - "LITTLE FOXES OF THE PRAIRIES"

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INTRODUCTION

In the proceedings of the second Endangered Species and Prairie Conservation Workshop, I reviewed the National Film Board production of "Return of the Swift Fox" (Carbyn 1991). Since then another film produced by TV Ontario and NHK Enterprises Japan originally slated with the same name was released. Upon discussion between the co-producer Janet Foster and myself, the title was changed to "Little Foxes of the Prairies." Even though the message of both films is the same, in my view the quality is not. The second film has been far superior in capturing the essence of the project; a fact that partly reflects the work accomplished in the time between the production of the two films. "Little Foxes on the Prairies" is an exceptional product because it puts the viewer right with the foxes in the prairies.

THE MESSAGE

The Swift Fox (*Vulpes velox*) is a "flagship" species in that it captures the public's attention. Its reintroduction is a project that brings back an attractive mammal to an area where it used to be quite common. The public strongly identifies with the notion of endangered species. The real problem, however, is not that Swift Foxes are an endangered species, because in fact they are not. The species is still quite common in the southern portions of the range. Some time during the 1930s it became extirpated within its northern range. It is, therefore, appropriate to return the species where it belongs, because it adds a "missing link" to the ecosystem.

Fundamentally more important, though, is the protection of mixed grass prairies. This biome has been one of the most threatened areas on the North American continent. In Canada, transformation of native mixed grasslands to farmland involves some 80% of available areas. Only by default, not design, are some 20% of the mixed grasslands still left. These areas are found along heavily eroded, hilly areas (difficult to cultivate) or in very dry regions. Ploughing of native prairies has little impact on the human consciousness. Expressed in another way, unless you are a botanist, people generally do not get "excited" about grasses. For example, in Canada, based out of Calgary, there has existed for years a thriving "Swift Fox Conservation Society" but nowhere in Canada is there a "Native Prairies Conservation Society." Repeated recommendations for a name change from "Swift Fox Conservation Society" to "Swift Fox and Native Prairie Conservation Society" has fallen on "deaf" ears. People do identify with animals—not all animals though. Rats can be poisoned at dumps or granaries without sympathy. Wolves, on the other hand, are dealt with differently. On the prairie, Swift Foxes and Burrowing Owls (*Athene cunicularia*) are two species with great appeal. The common "gopher", i.e., Richardson's Ground Squirrel (*Spermophilus richardsonii*), falls into the "rat category"—poison and destroy it at will, no questions asked. What is needed is a holistic message—protect Swift Foxes, protect grasses, and protect "gophers"—they are all important. This film provides that message.

OBJECTIVITY AND SCIENTIFIC ACCURACY

In dealing with such a charismatic and charming species one could, and should, turn a blind eye to some of the anthropomorphisms, however, they ought to be noted. "Father" fox "Bert" from Colorado is noted as having married a "local girl" and he is a "good father, playful and patient with the kids." A more serious statement is that the adults "teach lessons of behaviour." Much of fox behaviour observed at den sites is genetic or inherited and through trial and error the behavioral repertoire of young foxes is expanded. It is noted that the first foxes ever born in captivity were at the Calgary Zoo. That is not correct. Swift Foxes were bred at several smaller zoos and possibly at a larger zoo prior to the 1970s.

Footage of the Swift Fox playing at the den was delightful and commentary generally appropriate. Little do the viewers know that these shots were taken only a few feet away from the comforts of a vehicle.

IMPORTANCE TO PRAIRIE CONSERVATION

I rate this film exceptionally high in achieving an important goal—telling the story of an important conservation issue—saving the native prairies. The clarity of the message is backed by appropriate images. Well chosen and dramatic are the images of a patchwork of cultivated areas next to native grasslands and Swift Foxes enjoying life to the fullest in untrammelled native prairies. On seeing this film, how can anyone ever say "why spend time and effort in protecting what is left of our native grasslands?"

ARTISTIC IMPRESSION

This film shows only the very best footage. Colour balance is excellent and the images clear and crisp. The quality of photography was very even. Almost all the footage with wildlife in it had the animals completely in the frame, and where the animal was only partially involved, the motion was towards the viewer. The background music was superb and blended well into the narration. An interview with one field investigator comes across flat and stilted. A bit more "spark" would have added to the vitality of the film. Minor criticisms should not detract from the important conclusions. This film is a winner. The producers are to be congratulated for a job well done.

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BLACK-FOOTED FERRET RECOVERY IN CANADA

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ABSTRACT (Schroeder 1992)

The Black-footed Ferret (*Mustela nigripes*) is extirpated in Canada, with the last museum specimen taken near Climax, Saskatchewan in 1937. A total of 20 ferret specimens originate from southwestern Saskatchewan, with one recorded in Alberta but thought to come from Saskatchewan. Decline in ferret populations in Canada and the United States, where they were found in 12 states, is directly associated with early European settlement of the North American great plains region and the corresponding expansion of a farming and ranching economy. The reduction of ferrets was mostly indirect as their primary prey, the prairie dog (*Cynomys* spp.) were directly affected by these agricultural practices through habitat disruption, poisoning, trapping, and hunting. The Black-tailed Prairie Dog (*Cynomys ludovicianus*) population, near Val Marie, Saskatchewan, which would serve as a base for ferret recovery in Canada, is also small and listed as vulnerable.

After the capture of 18 wild ferrets in Wyoming in 1986, a captive breeding program has successfully raised the number to more than 300 in just five years. With a secure source of animals, reintroduction to the wild began in 1991 in Wyoming. In 1992, the Metro Toronto Zoo finished a large ferret breeding facility and is awaiting the arrival of 30 pairs of ferrets. This is part of a strategy to preserve as much genetic diversity of the original 18 wild ferrets as reasonably possible. This recovery plan incorporates the management objectives of the Black-footed Ferret breeding program of the American Association of Zoological Parks and Aquariums.

The purpose of the Canadian recovery plan is to downlist ferrets from extirpated to endangered. To achieve this, a habitat suitability or rating index was calculated for the Val Marie prairie dog complex using dated data to determine if the amount of habitat (prairie dogs) currently available is sufficient. The rating index was calculated to equal 6.68. A rating index of 30 is considered minimal for ferret recovery. The best option for recovery is to expand the existing prairie dog complex at Val Marie by a factor of five, if ferret recovery is to occur at all.

The feasibility of reintroducing ferrets is to be evaluated over a five year period, beginning 1992. Most of the effort should be directed toward censusing the Val Marie prairie dog complex and calculating the habitat rating index annually. At the same time, steps should be taken to improve the prospects for expanding the existing prairie dog population. The Canadian Parks Service, the major landowner of Black-tailed Prairie Dog habitat in the Val Marie district, could make a start by developing a ferret management plan for the proposed national park area. Other landowners will eventually need to become involved through cooperative agreements. After five years of management and monitoring Black-tailed Prairie Dogs, a decision to proceed with reintroduction or continue with prairie dog enhancement is needed.

Public awareness programs regarding the ferret recovery effort and especially an awareness of importance of prairie dog ecology to prairie biodiversity are needed. This communication effort may be combined with the distribution of a ferret "wanted" poster as a means of soliciting ferret sightings from the public and rigorously evaluating the report to determine if further verification is warranted. This is a cost effective method of determining the presence of any remnant ferret population that may still survive.

Finally, the draft recovery plan outlines, after careful evaluation, the steps necessary for a full reintroduction program to proceed. Ferret reintroduction is not expected to occur any time soon. There are serious biological limitations (low prairie dog numbers) that must be addressed first. Socio-political difficulties are anticipated but cooperation with the major landowners, who are primarily federal and provincial governments, is expected to be largely favourable.

Costs of the program for the first five years are limited to supporting monitoring and enhancement of prairie dog populations, public awareness campaign, and developing a ferret sighting report. The major exception here is the establishment and operation of the ferret breeding facility in 1992 at the Metro Toronto Zoo. If reintroduction does eventually proceed, associated costs are expected to rise due to the increased level of activity.

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5. SUMMATION

TO OUR YOUTH AND FUTURE GENERATIONS

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THE ESSENTIAL HABITAT

Habitat is shelter, food, air, water, all those things that support life for every species, including humans. Every living thing is totally dependent on the largesse supplied by mother earth. Our generation has failed, and although we're trying, you and your children may have to fight for your life.

You must look not only at habitat but the very system that governs society throughout the world. There are major road blocks which must be overcome to meet the challenge that our generation will leave you. Neither our bias nor remaining time, will allow us to give you the clean earth you should have. "I found the enemy, and he is us."

In 1987 at London, on the occasion of the launch of "Our Common Future" Chairman Gro Harlem Brundtland made a presentation and comments to, and about, young people. "Our common future will require new energy and openness, fresh insights, and an ability to look beyond the narrow bonds of national frontiers and separate scientific disciplines." You have those attributes.

"You are young and fresh, at the beginning of your careers. Your vision is not restricted by narrow boundaries, lack of foresight, or greed. You will have the time, and action is essential. You are in far greater danger than we, if we fail to change the practices that have caused the problems. Do not take anything we say or recommend as gospel. Honesty has not had priority in our board rooms, parliaments, legislatures, city halls, financial circles, or even between ourselves. For far too long, short term gain, without thought of the consequences has been our policy. Be suspicious, investigate, and criticize. We need your input, not as subordinates but as equals!"

It is my belief that the human race may be an endangered species. Yet not one of our generation will live to be affected! There are things that must be, and will be said to assist you to perhaps obtain a better understanding of the task you face to provide a better life for yourselves and your children.

These are your challenges!

Free enterprise is the most effective method of distribution. There is no such thing, but our imitation is more efficient that others. Many changes and controls are required, hopefully by negotiation and cooperation by industry, government, and the general public.

Money was created as a catalyst to improve deficiencies of the barter system. It evolved to the point where, many generations ago, Baron Rothschild commented that whoever controlled the money, controlled the nation, regardless of which government was in power. This evolution continues, and unless action is taken, it will be the multi-nationals, governed by the very few, who will control the world, regardless of governments.

The patent system was initially developed to protect the rights of those who had developed or invented a product which was marketable. It is a reasonable idea, providing the financial books are open and there are limits on profits. Evolution has created monopolies and oligopolies who control the most valuable patents in the world! The surrender of our federal government to the pharmaceutical barons, is an example of tremendous power. The research that Trade Minister Wilson extols will cost the citizens of Canada billions of dollars.

Recessions for the rich, and some not so rich, are a pause and opportunity for increasing wealth, at fire sale prices. Costs are loaded on the unemployed, small investors, small business, and the general public. Massive debt accumulated by irresponsible governments, exacerbates the problem.

Politics in this country, we do not have true democracy, but a four year dictatorship. Governments do not own any money. They are trustees for the money they have taken from you! The most blatant example of greed and irresponsibility is the pension plan that our Members of Parliament have given themselves. This has filtered down into provincial and municipal areas. It seems that the public trough is infinite. In major issues, the public must be able to control or defeat government, regardless of the date. In our country, and that of our southern neighbour, government, "By the people and for the people" is a farce. Changes will not be made by our politicians, unless it is forced during an election. This is one of the toughest challenges you will face!

Growth - The earth's resources are finite. Every item that any species on this earth uses or consumes is either renewable or irreplaceable. Our economists insist that without growth, there is stagnation. Growth really means exploitation of resources, or the concentration on one at the expense of others. Our knowledge of the millions of items which form the earth's resources is infinitesimal! Our ego approaches infinity! What are the costs of our demand for growth? Let's give each economist a rubber sphere representing the earth, pumped up to the critical stage. Each year they would be required to increase the pressure by the percentage by which our economy should grow. Each should be given a bundle of money to clean up the mess when the blow up comes. Money will be worth nothing, for the human race may not exist.

Elimination of poverty - This is one of the most important recommendations in "Our Common Future." A large portion of the population on earth are destroying the environment just to survive. Yet millions die each year from starvation. A solution here will have a major impact on the developed countries, and a decline in the quality of our life. Our generation is not ready, even to eliminate the poverty in our own country. Cooperation, rather than confrontation is the only way to even start to alleviate this disgrace.

I once said that if you brought together a group of ten people to solve a problem, there would be ten solutions. There were twenty-two members from every part of the world in the Commission which unanimously approved "Our Common Future." They and I, believe that human will and cooperation can solve the problems facing this earth.

A problem can not be solved unless you strip away all the factors which obstruct knowledge of the real problem. Every statement I have made is true. Solutions are not difficult to identify, but tremendous power and effort will endeavour to maintain the status quo. However, the most powerful factor on earth, next to nature, is an educated and aroused public.

Power to be effective, must be used wisely and for the benefit of the many. I expect to be around for quite a number of years, and am looking forward to seeing you, supporting you, and hopefully will see the progress you will make to meet the goals which are so important.

Many years from now, I hope you can say, "We have searched for the enemy, and he has become a friend."

GRACE THAT WAS GIVEN AT THE BANQUET

Jennifer Shay
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It was land and water

that brought life into being,

and that sustains and

renews life.

May we respect and

conserve land and water,

and give thanks for

the food we are about to receive.

THE FUTURE OF PRAIRIE CONSERVATION

Ian Milliken

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It is indeed an honor and challenge for me to address you from the perspective of an active mixed farmer with a wildlife background.

The future of prairie conservation is so closely linked to agriculture it can be summed in two words, Land Ethics. As early as 1949, Aldo Leopold (1991) said, and I quote, "I have no illusion about the speed and accuracy with which an ecological conscience can become functional. It has required 19 centuries to define decent man-to-man conduct and the process is only half done; it may take as long to evolve a code of decency for man-to-land conduct."

In the last 40-some years since 1949, prairie farmers have by-and-large gradually divorced themselves from any semblance of a code of decency related to land or water and its native flora and fauna. However, farmers are not ultimately to blame for that loss of ethics and the resulting change in the prairie landscape. On Friday, Crawford Jenkins mentioned how the productivity of our farmers has increased from where one farmer produced enough for one family now produces for thirty. In the years following the dirty '30s and the world wars, farmers were encouraged by government quota delivery systems to put more land under the plow and produce more grain. As urban aspirations and technology changed so did those of the rural community. "So-called experts" said that farmers had to expand to survive; bigger was better. Modern technology produced tractors, cultivators, combines that were bigger, better, and far more expensive. The circle turned as the system cried for more and more efficient production. The quota system and large machinery made it more economical to farm through rather than around wetlands, bluffs, and idle prairie sites. And so the farmer's tie to a land ethic was broken by a system fuelled by government policies and society's demands that they become more efficient or perish. But, I haven't told you anything that most of you don't already know.

What can we do to reverse this trend which continues today and ultimately therein lies the future of prairie conservation. In the immediate future, for at least the next 15 to 20 years, the farmer will have to be reimbursed. Just as we encouraged and rewarded him to destroy his land ethic, we will have to pay to regain it. And, as you know, there are now some programs and personnel in place promoting and working to that end. In Manitoba, the Critical Wildlife Habitat has done an excellent job to date with the funds available. The North American Waterfowl Management Plan, although focused primarily on waterfowl, has the potential to impact a diversity of flora and fauna, and it is a classic example how various organizations, wildlife, and agriculture can work together toward a common end.

Over the long-term, governments and society must send clear and non-conflictive signals to the rural community that small family farms will be supported and maintained and that the past system of mono-culture wheat production must be diversified. Clearly some of those signals are there. Sustainable agriculture is with us, Farming For Tomorrow groups are coming to the forefront, Prairie Farm Rehabilitation Administration has the Permanent Cover Program, and naturalists and environmentalists have a higher profile in our society.

Yes, there is a future, but we have only seen the light at the end of the tunnel. The quota delivery system is still in place, and we now have the Gross Revenue Insurance Plan (GRIP). If the family farm and rural community are to survive under diversified sustainable agriculture systems, GRIP must be terminated and replaced by a more ecologically-friendly subsidization program.

In a short 50 years, we have destroyed much of what took centuries to build. We do not have that much time to rebuild it. Agriculture cannot survive with a system that considers its resources unlimited. The current scenario for agriculture and prairie conservation is at a turning point. From what I have heard at this workshop, it is very clear there is a strong commitment to make that change. Where there is a will, there is always a way.

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SUMMARY

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The workshop and these proceedings are a success because of the number and diversity of people present who are concerned about the prairies, its wildlife and its people; the prairie landscape. The almost 100 papers have come from the efforts of the steering committee, the session chairs, the speakers, and particularly the authors who took the time to document their words.

During the workshop, one-third of the presentations were about agricultural perspectives of wildlife issues, our target subject. Of the remaining two-thirds many speakers incorporated agricultural concerns in their wildlife talks. As biologists we are becoming more aware of the effect of non-biological topics such as economics and ethics on the wildlife and habitats that we study. Also encouraging at this workshop was the involvement of landowners who made up one-third of the speakers. It is this continued dialogue that will help us to find new solutions to create a healthy prairie economy and ecology.

Most working sessions had considerable discussion after the presentation of papers. Some session chairmen have provided summaries of this discussion in these proceedings and some speakers have incorporated the comments into their papers. Here are the notes from two sessions to provide examples of the outcome of the working sessions.

Loney Dickson chaired the session on the concerns for grassland wildlife. The session concluded that researchers and biologists need to communicate more often with landowners, both ranchers and farmers. Biologists not only need to pass on the results of their studies but also talk to landowners while the studies are underway. This community level contact will increase the understanding both ways. Biologists and landowners are more likely to understand each other's perspective, consequently the conclusions of their studies are more likely to be implemented. The session encouraged more research on Crown lands to identify the types of grazing regimes needed for various wildlife communities and for grazing animals. Grazing should encourage the creation of "natural" conditions to benefit livestock and wildlife. Finally, outdoor recreation needs to be integrated with grazing and wildlife to provide greater diversity in ranch income. Thus the concerns for grassland wildlife need to be combined with human activities and considered as parts of a grassland landscape.

From the Multi-use Water Management session John Towle writes, "In today's society, we are becoming more aware of the need to plan, construct, and manage projects in an integrated and coordinated approach. The issues of land and water are becoming more complex and new approaches are needed to ensure development is in harmony with our environment. In this session we looked at case studies where people working together have developed or are planning to develop multi-use water management projects with attempt to fulfil the following goals of Manitoba's land and water strategy component of sustainable development: to sustain resources, enhance productivity, and improve environmental quality including human health; to improve and diversify income and job opportunities; to manage resource and related activities so as to preserve development options for future generations; and to protect natural systems, maintain the genetic diversity of species, and preserve the resilience and productivity of the ecological system." Clearly water management is another component of the prairie landscape.

During the final plenary session three speakers—Monte Hummel, Robert Sopuck, and Ian Milliken—told us of their vision for prairie Canada, the prairie landscape.

Monte Hummel, President of World Wildlife Fund (WWF) Canada, reminded the audience of the balance between preservation and sustained use (conservation) that is promoted in the Prairie Conservation Action Plan (PCAP). Many speakers pointed out the negative environmental impact of current agricultural subsidies. Monte pointed out that the new GATT (General Agreement on Tariffs and Trade) agreements may change the foundation of agricultural subsidies. Under the proposed revisions to GATT, production subsidies will not be allowed. However, subsidies to protect the environment or to diversify the economy will be acceptable. Thus a landowner could be paid to maintain permanent cover for soil and wildlife conservation rather than for ploughing marginal lands. Likewise the landowner could be paid to diversify his income by building a guest house for farm holidays, thus promoting local tourism. He challenged us to implement the PCAP and to be prepared to measure our progress in 1995 at the next Prairie Conservation Workshop. At that time we need to update the PCAP based on the psychology of its success. He said that WWF is prepared to help but does not want to lead the charge.

Bob Sopuck, a landowner and advisor to Manitoba Premier Filman, spoke of his broad involvement in the prairies as a hay farmer, tour guide, outfitter, fisheries biologist, and civil servant. As a hunter he wondered if he was out of place among conservationists but there were more hunters in the audience than he knew. Nevertheless this concern gave rise to his notable quote, "You can't understand the environment unless you eat part of it." As the Premier's environment spin doctor he warned us that, "for every problem there is a solution that is quick, short, and wrong." As we seek solutions to environmental problems we must remember that the source of our pay cheque colors our thinking. What we need to achieve are millions of decentralized decisions on behalf of the environment. While striving to achieve this goal with landowners we must realize that they are attached to their land, their house and home.

Ian Milliken, a fourth generation farmer from Reston, Manitoba, has provided his own text which precedes this paper. In it he argues that wildlife has to pay its way. He believes the new GATT agreement has great potential to achieve this goal.

So what are the bottom lines from the workshop. Here are two that struck me. Ninety percent of the prairies is privately owned, and billions of dollars are spent each year on agricultural subsidies to these landowners. From the summary discussion we heard that we need to understand people, their lifestyle, and the origin of their ideas. In the introductory session we were cautioned that wildlife has to pay its way. The solution to the long-term conservation of prairie wildlife may lie in the new GATT agreement and the opportunity to channel billions of dollars into "amber" or environmental subsidies.

When we think of the fourth workshop, we need to define a theme and objective to build on the first three. Timothy Myres suggests that we review how the prairie soils and grasses replenish and stabilize the prairies, how nutrients are recycled into the soils, the optimal conditions for microbial activity, and the effects of various land use and inputs (fertilizers and pesticides). Two groups of organisms that have yet to be viewed adequately at the workshops are insects and fishes.

Although we have much to learn about the ecological interactions of the natural prairie ecosystems we need to find a new perspective for solving biological problems. Likewise landowners have many economic and agricultural problems to solve. We need to consider the prairies an integrated landscape of wildlife, its habitat needs, landowners and their desire to live on the land. The next workshop must continue this dialogue to work toward a sustainable prairie landscape.

Finally, I wish to thank the steering committee for all their hard work over two years to plan this workshop. Their efforts are rewarded by the large attendance of 350 registered participants who heard 132 presentations in 56 sessions. In the 3-day workshop there were enough talks to fill 11.5 days of presentations.

Until the next workshop I urge you to work toward conservation as though your life depends on it, because it does!

Proceedings of the Third Prairie Conservation and
Endangered Species Workshop

Holroyd Dickson Regnier Smith

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